

INK-JET RECORDING DEVICE AND INK CARTRIDGE**CROSS-REFERENCE TO RELATED APPLICATION**

This application is a continuation of U.S. Patent Application Serial No. 10/045,933, entitled Ink Jet Recording Device and Ink Cartridge, filed October 19, 2001, presently allowed, the contents 5 of which are hereby incorporated by reference herein.

BACKGROUND OF THE INVENTION

The present invention relates to a technique for identifying an ink cartridge which supplies ink at an appropriate negative pressure 10 to a recording head which ejects ink droplets in response to print signals.

An ink-jet recording device is usually configured so that an ink-jet recording head for ejecting ink droplets in response to print signals is mounted on a carriage which makes reciprocating 15 motion in a direction of the width of a recording sheet, and so that ink is supplied from an external ink tank to the recording head. In the recording head of a small-size type, an ink storage container such as an ink tank or the like is detachably attached to the carriage. On the other hand, in the recording head of a 20 large-size type, the ink storage container is set on a frame or casing of the recording device, and connected to the recording head through an ink supply tube.

The ink tank mounted on the carriage is usually configured so that a porous member such as sponge or the like is contained 25 in the ink tank and impregnated with ink in order to reduce the change of pressure stemming from waving of ink or the like caused due to the reciprocating motion of the carriage.

Even in the case where the recording head is supplied with

ink from a large-capacity ink bag, set on the frame, through the ink supply tube, ink is supplied to the recording head through a sub-tank having a damping function for preventing the change of ink pressure due to the motion of the carriage, in order to prevent the change of ink pressure from being caused by the bending of the tube due to the reciprocating motion of the carriage.

Hence, the former has a problem that the size or weight of the ink tank is increased by the volume of the porous member contained in the ink tank in comparison with the volume of ink capable of being contained in the ink tank. The latter has a problem that the recording device is complicated in structure because a mechanism is required for preventing the change of ink pressure owing to vibration.

Both recording head and ink have been further improved for the purpose of improving print quality, and ink adapted to the recording head is designated by the maker.

On the other hand, because the ink cartridge is formed as a rectangular parallelepiped container from the point of view of the structure, or the like, of the recording device, there is a problem that the ink cartridge adapted to the recording device can be hardly identified and may be selected by mistake.

To solve the problem, protruded portions are formed in an ink cartridge holder of the recording device, and recessed portions are formed in the ink cartridge so as to be adapted to the protruded

portions. That is, an ink supply needle passes through an ink supply port only when the protruded portions fit into the recessed portions.

If the weight of the ink cartridge, that is, the capacity thereof is reduced to make high-speed printing possible, there is however a problem that the number of kinds of recessed portions allowed to be formed in the narrow bottom portion of the ink cartridge is limited.

SUMMARY OF THE INVENTION

10 The present invention is based on this problem, and an object of the invention is to provide an ink-jet recording device in which the number of kinds of shapes for judgment of adaptability can be increased by use of a relatively narrow space, and to provide an ink cartridge adapted to the ink-jet recording device.

15 To achieve the foregoing object, the present invention provides, for example, an ink-jet recording device for supplying ink to a recording head from an ink cartridge provided with an ink supply port, wherein: each of three-dimensional space axes is divided into a plurality of sections to provide a plurality of coordinate points, and identification members protruded in a direction of insertion of the ink cartridge are formed to reach the coordinate points selected in accordance with identification items.

20 The present invention also provides, for example, an ink cartridge having a container provided with an ink supply port

in one of side surfaces of the container and containing ink, and identification fitting portions formed in the one side surface so as to correspond to the identification members of a recording device for receiving the cartridge, wherein: each of
5 three-dimensional space axes containing the one side surface is divided into a plurality of sections to obtain a plurality of coordinate points; and the identification fitting portions are disposed at the coordinate points selected in accordance with identification items so that the identification fitting portions are located to abut on end portions of the identification members.

Because a space is used three-dimensionally so that identification pieces are disposed in the space, the number of combinations is increased.

15 The present disclosure relates to the subject matter contained in Japanese patent application Nos.:

2001-033074 (filed on February 9, 2001);

2001-147418 (filed on May 17, 2001);

2001-149315 (filed on May 18, 2001);

20 2001-264896 (filed on August 31, 2001);

2000-321207 (filed on October 20, 2000); and

2000-320319 (filed on October 20, 2000),

which are expressly incorporated herein by reference in their entireties.

BRIEF DESCRIPTION OF THE DRAWINGS

Figs. 1A and 1B are views showing the front and rear structures of an ink cartridge according to one exemplary embodiment of the present invention.

5 Figs. 2A and 2B are views showing a state in which side surface-forming members for sealing the ink cartridge of Fig. 1 are removed.

Fig. 3 is a view showing the structure of the bottom surface of the ink cartridge of Fig. 1.

10 Fig. 4 is an enlarged explanatory view showing the insertion error prevention-forming region formed in the ink cartridge of Fig. 1.

15 Fig. 5A is a sectional view showing a valve-closed state in an embodiment of the differential pressure valve constituting a negative pressure generating mechanism, and Fig. 5B is a sectional view showing a valve-opened state in the embodiment of the differential pressure valve.

20 Fig. 6A is a partly cutaway view showing an ink cartridge holder adapted to the ink cartridge of Fig. 1, and Fig. 6B is a view showing a state in which the ink cartridge is attached.

Fig. 7 is a front view mainly showing the filter chamber side ink flow path formed in the ink cartridge of Fig. 1.

Fig. 8 is a view showing another embodiment of an ink cartridge according to the present invention.

Figs. 9A and 9B are views showing the external appearance of the front and rear of the ink cartridge according to a further embodiment of the present invention.

5 Figs. 10A to 10D are a top view, a front view, a bottom view and a side view of the ink cartridge of Fig. 9.

Fig. 11 is a sectional view showing an embodiment of the carriage to which the ink cartridge of Fig. 9 is attached.

Figs. 12A and 12B are views showing a process in which the ink cartridge is attached to the carriage of Fig. 9.

10 Fig. 13 is a perspective view showing the structure of the opening surface of the container body constituting the ink cartridge of Fig. 9.

15 Fig. 14 is a perspective view showing the structure of the bottom surface of the container body constituting the ink cartridge.

Fig. 15A is a perspective view showing the structure of the front surface of the container body constituting the ink cartridge of Fig. 9, and Fig. 15B is a view showing a through-hole formed in a communication groove.

20 Fig. 16 is an enlarged view showing the sectional structure of the negative pressure generating mechanism-storing chamber.

Fig. 17 is an enlarged view showing the sectional structure of the air communication valve-storing chamber.

Figs. 18A and 18B are a perspective view and a front view

showing an embodiment of the identification block, and Fig. 18C is a view showing coordinate points set in the identification block.

Figs. 19A and 19A' to Figs. 19F and 19F' are perspective views and front views showing the form of the identifiable protruded portions of the identification blocks.

Fig. 20 is a perspective view showing an embodiment of the carriage configured so that a plurality of ink cartridges can be received.

Fig. 21 is a perspective view showing a state in which the direction of the carriage is changed.

Figs. 22A and 22B are enlarged views showing a neighborhood of the ink supply needle in the carriage and a neighborhood of the ink supply port in the ink cartridge.

Figs. 23A to 23C are views showing shapes suitable for identification pieces, and Figs. 23D to 23F are views showing shapes unsuitable for identification pieces.

Figs. 24A to 24C are views showing the limiting portion which is to be formed in the identification block so that the identification pieces are identified by the identification block.

Figs. 25A to 25D are views showing another embodiment of the identification pieces.

Figs. 26A to 26D are views showing the limiting portion which is to be formed in the identification block so that the

identification pieces are identified by the identification block.

Figs. 27A to 27C are perspective views and a bottom view showing an even further exemplary embodiment of the ink cartridge according to the present invention.

5 Figs. 28A and 28B are views showing the sealing structure of the ink injection port in the ink cartridge of Fig. 27.

Fig. 29 is a perspective view showing another embodiment of the identification block.

DESCRIPTION OF THE PREFERRED EMBODIMENT

10 The present invention will be described below in detail on the basis of various exemplary embodiments shown in the drawings.

Figs. 1A and 1B show an ink cartridge 1 according to one embodiment of the present invention. Figs. 2A and 2B show the front and rear structures of a container body 8 constituting 15 the ink cartridge 1. Fig. 3 shows the structure of the container body 8 viewed from the bottom surface thereof. The container body 8 is partitioned into upper and lower regions by a wall 2 (Fig. 2B) extended substantially horizontally. A first ink chamber 3 is formed in the lower region. A differential pressure 20 valve-storing chamber 4 (Fig. 2A) which serves as a negative pressure generating mechanism which will be described later, a filter chamber 5 for storing a filter, and second and third ink chambers 15 and 16 are formed in the upper region.

The differential pressure valve-storing chamber 4 and the

filter chamber 5 are separated from each other in a direction of the thickness of the container body 8 by a wall 6. A valve seat 6a (Fig. 2A) constituted by a protruded portion is formed on the differential pressure valve-storing chamber side of the 5 wall 6, and through-holes 6b are formed through the wall 6. A frame 10 (Fig. 2B) for fixing a filter 18 is formed on the filter chamber side of the wall 6.

As shown in Fig. 2B, The upper and lower chambers are communicated with an upper region opening 5a of the filter chamber 10 .. 5 via a circuitous flow passage (a flow passage turning on and along a vertical plane) defined by walls 11a and 11b extending vertically and walls 11c and 11d extended horizontally on one side portion of the ink cartridge (see also Fig. 7).

On the other hand, the differential pressure valve-storing chamber 4 connected to the filter chamber 5 by through-holes 6b is communicated with an ink supply port 14 by a flow path 13 which is formed so as to be isolated from the first ink chamber 3. The ink chambers 15 and 16 are disposed so that the differential pressure valve-storing chamber 4 and the filter chamber 5 are put between the ink chambers 15 and 16. Air bubbles contained in ink ascending from the first ink chamber 3 are trapped in the ink chambers 15 and 16.

A wall 20 extends horizontally such that a slight gap is formed between the wall 20 and the outer wall of the container

body 8 to define a space or air flow passage 21. The wall 20 is formed in the upper portion of the container body 8. The flow passage (i.e. the space or air flow passage) 21 is communicated with an air-opening port 17 through an air-permeable film 24a and a capillary 22 (Fig. 2A). The flow passage 21 is also communicated with the first ink chamber 3 through a cylindrical portion 25. That is, the first ink chamber 3 is connected to the air-opening port 17 through the cylindrical portion 25, the air-permeable film 24a and the capillary 22.

10 A meandering groove formed in the differential pressure valve-storing chamber (4) side surface of the container body 8 is sealed with an air-impermeable film (Fig. 1A) 37 to thereby form the capillary 22. The capillary 22 has one end 22a connected to the air-opening port 17, and the other end communicated, through 15 a groove 23c, with a region formed between the air-permeable film 24a and the air-impermeable film 24b. The air-permeable film 24a extends in the middle of the depth of a recessed portion 23 formed in the container body 8. Specifically, a film support portion 23a (Fig. 2A) is formed in the middle portion of the 20 recessed portion 23 so that the air-permeable film 24a is bonded onto the film support portion 23a in a stretched state. On the other hand, an air-impermeable film 24b (Fig. 1A and 1B) is bonded onto the upper surface 23b of the recessed portion 23 in a stretched state, so that air inside the container body 8 is insulated from

atmosphere at this portion.

The flow passage 21 is communicated with the first ink chamber 3 through the cylindrical portion 25. An opening 26 is provided above the upper portion of the cylindrical portion 25 and sealed 5 with an air-impermeable film 27 (Fig. 1A and 1B) which can be deformed elastically. Further, a normally closed type valve not shown is received in the cylindrical portion 25.

In this configuration, the film 27 is elastically deformed by an operating rod which comes in to contact with the same when 10 the ink cartridge 1 is attached to the recording device, so that the valve is opened. As a result, the first ink chamber 3 is put in communication with the flow passage 21.

As shown in Figs. 2A and 3, a recessed portion 30 is formed just below the differential pressure valve-storing chamber 4, 15 and opened to the lower surface side in which the ink supply port 14 is provided. Identification protruded portions 31 for identifying the ink cartridge are formed in the recessed portion 30. Ink injection ports 33 and 34 for charging ink at the time of manufacture of the ink cartridge are also formed in the lower 20 surface of the container body 8.

As shown in Fig. 4, in the recessed portion 30, the direction X of the length of the container is divided into three, the direction Y of the width of the container is divided into two, and the direction Z of the height of the container is divided into six

to thereby form coordinate points. A plurality of identification protruded portions 31-1, 31-2, 31-3 and 31-4 are disposed at coordinate points (X₁, Y₂, Z₁), (X₁, Y₁, Z₆), (X₃, Y₂, Z₃) and (X₃, Y₁, Z₅), respectively, by selecting an appropriate 5 combination from the coordinate points, to thereby constitute the identification fitting portions. It is a matter of course that when the coordinate points are set and selected to correspond one-by-one to, for example, a kind of ink cartridge and/or a kind of ink, an ink cartridge different in the kind of ink can 10 be prevented from being attached to the recording device by mistake.

Figs. 5A and 5B show an example of the differential pressure valve serving as a negative pressure generating mechanism. Fig. 5A shows a state in which the valve is closed. Fig. 5B shows a state in which the valve is opened. A membrane valve 40 has 15 an annular thick portion 40a in its outer circumference, a thick portion 40c provided with a through-hole 40b in its center, and an approximately S-shaped bent portion 40d provided near the thick portion 40a. The membrane valve 40 is fixed to a cylindrical holder 41, which is fitted into the differential pressure 20 valve-storing chamber 4. A coiled spring 42 is inserted into between the center thick portion 40c and the container body 8 (in this embodiment, between the center thick portion 40c and the cylindrical holder 41). The elastic force of the coiled spring 42 is adjusted so that the membrane valve 40 can be separated

from the valve seat 6a at the point of time when predetermined negative pressure due to ink consumption in the recording head acts on the ink supply port 14 (Fig. 5B), and the membrane valve 40 can be made to contact the valve seat 6a elastically at the 5 point of time when the ink supply to the recording head is terminated (Fig. 5A).

The container body 8 configured as described above is formed into a sealed container by sealing the filter chamber side surface thereof with a cover 36 and by sticking the air-impermeable film 10 37 onto the differential pressure chamber side surface thereof.

In the condition that the ink supply port 14 is sealed with a film which can be broken by insertion of an ink supply needle, an ink injection device is connected to the ink injection ports 33 and 34 in the bottom surface and the sealed container is filled 15 with ink. After the sealed container is filled with ink, the ink injection ports 33 and 34 are sealed with a plug(s) or an air-impermeable film(s). Thus, the sealed container is finished as an ink cartridge 1.

Fig. 6A shows an example of a cartridge holder 50 adapted 20 to the aforementioned ink cartridge 1. The cartridge holder 50 has a base portion 51, walls 52, 53 and 54 provided on the base portion 51 so as to correspond to the front surface of the ink cartridge and the two side surfaces thereof adjacent to the front surface, a protruded portion (or identification fitting 25 portion) 55 provided on the base portion 51 and located in position

corresponding to a vertical recessed portion of the ink cartridge, and identification pieces (or identification members) 56 extending in an insertion/removal direction of the ink cartridge for detecting the kind of the ink cartridge.

5 Specifically, the identification pieces 56 are constituted by a plurality of pieces 56-1, 56-2 and 56-3 which are selected to have lengths to reach the lower surfaces of the identification protruded portions 31-1, 31-2, 31-3 and 31-4 formed in the recessed portion 30 of the ink cartridge from the surface of the carriage, 10 that is, to have sizes to prevent collision of the identification pieces 56 with the identification protruded portions 31-1, 31-2, 31-3 and 31-4 which are identification fitting portions, when an adapted ink cartridge is received.

Hence, when the ink cartridge adapted to the carriage (the 15 holder 50) is to be attached to the holder 50, the identification pieces 56 allow the ink cartridge to be fitted to the holder 50. On the contrary, when an incompatible ink cartridge is to be attached to the holder 50, the identification pieces 56 of the carriage (the holder 50) cooperate with the identification 20 protruded portions 31 of the cartridge to prevent the ink supply needle from moving more into the ink supply port 14. In addition, an ink supply needle is not illustrated in Figs. 6A and 6B, but the ink supply needle is provided on the base portion 51 of the holder 50 and located in a region surrounded by the walls 52,

53 and 54, i.e. in a region opposite the protruded portion 55 with respect to the identification pieces 56.

In this embodiment, when the ink cartridge 1 is attached to the ink cartridge holder 50, the front side three surfaces 5 of the ink cartridge 1 and the recessed portion C (Fig. 6B) of the ink cartridge 1 are guided by the walls 52, 53 and 54 and the protruded portion 55 respectively so that the ink cartridge 1 is positioned to a predetermined location as shown in Fig.

6B. Further, the film 27 is pressed by the operating rod (not shown) of the recording device to open the valve member installed in the cylindrical portion 25. Hence, the first ink chamber 3 is opened to the air through the flow passage 21, the air permeable seal 24a, the capillary 22, etc.

When ink is consumed by the recording head in this condition 15 so that negative pressure acts on the ink supply port 14, the membrane valve 40 receives differential pressure and is separated from the valve seat 6a against the urging force of the coiled spring 42. The ink in the first ink chamber 3 passes through the filter 18 and flows through the through-holes 6b into the differential pressure valve-storing chamber 4. The ink further 20 passes through the through-hole 40b of the membrane valve 40 and flows into the ink supply port 14 via the flow passage 13.

As shown in Fig. 7, when ink flows out of the ink supply port 14 so that negative pressure acts on the filter chamber

5, ink in the first ink chamber 3 is sucked into the upper region of the filter chamber 5 via a flow passage A formed by the wall 11 so as to extend substantially vertically, a flow passage B extending horizontally in the uppermost portion, a flow passage 5 C formed by the wall forming the filter chamber 5 and the wall 2 extending horizontally, a vertical flow passage D and a horizontal flow path E. In this manner, the ink in the first ink chamber 3 flows out of the bottom portion of the first ink chamber 3 via the two ink chambers 15 and 16. Hence, air bubbles contained 10 in the ink are trapped (i.e. stay) in the upper portions of the ink chambers 15 and 16, and are removed from the ink as much as possible before the ink flows into the filter chamber 5.

When ink is consumed in the aforementioned manner, ink in the first ink chamber 3 located in the lower section is sucked up to the filter chamber 5 located in the upper section, and 15 is then supplied to the ink supply port 14 through the differential pressure valve mechanism.

When ink in the ink cartridge 1 is consumed and the ink cartridge 1 is removed because ink in the ink cartridge is consumed 20 completely or because of exchange with a different kind of ink, the valve member in the cylindrical portion 25 for communication of the first ink chamber 3 with the flow passage 21 loses support by the operating rod of the recording device, so that the valve is closed. Further, the membrane valve 40 is urged to contact

the valve seat 6a elastically by the spring 42. Consequently, ink is prevented from being leaked from the ink supply port 14.

In the aforementioned embodiment, identification protrusions are formed to be integrated with the ink cartridge.

5 As shown in Fig. 8, alternatively, a recessed portion 60 may be formed in the container body 8 constituting the ink cartridge 1, and a frame 61 capable of being inserted and fixed to the inner circumference of the recessed portion 60 may be formed as a discrete member. Further, the identification protruded portions 31 may be formed in the inner surface of the frame 61 so that the frame 61 forms an identification block 62.

According to this example of an ink cartridge according to the present invention, by preparing the identification blocks 62 having the identification protruded portions 31 different in positions in accordance with kinds of the ink cartridges 1, the container bodies 8 per se can be used commonly for various kinds of ink.

Figs. 9A and 9B and Figs. 10A to 10D show the external appearance of a further exemplary embodiment of an ink cartridge according 20 to the present invention. The ink cartridge 71 mainly has a flat rectangular box type container body 72 having a closed side and an opposite opening side, and a cover 73 for sealing the opening side. An ink supply port 74 is provided on the leading end side in the direction of insertion of the ink cartridge into

a carriage (i.e. on the bottom surface of the container body 72 in this embodiment), and is offset in the lengthwise direction. Retaining members 75 and 76 are formed on respective sides of the upper portion of the container body 72.

5. A memory device 77 with electrodes 77a is provided in a recessed portion 72b below the retaining member 75 located on the ink supply port side. A valve-storing chamber 78 is formed below the other retaining member 76. A slit portion 79, extending in the insertion/removal direction of the ink cartridge 71, is formed near the ink supply port 74 and in the center region of the container body 72.

As shown in Fig. 11, a carriage 200 to which the ink cartridge 71 is attached is configured so that a recording head 201 is provided in the bottom surface. An ink supply needle 202 is provided to the carriage 200 to be communicated with the recording head 201. A cartridge pressing member is provided in a region far from a region in which the ink supply needle 202 is provided.

In this embodiment, a leaf spring or plate spring 203 is provided as the cartridge pressing member. A positioning protruded piece 204 is formed between the ink supply needle 202 and the leaf spring 203 to extend in the insertion/removal direction of the ink cartridge 71.

Electrodes 206 are disposed in a side wall 205 on the ink supply needle 202 side. A recessed portion 207 for engagement

with the protrusion 75a of the retaining member 75 are formed above the electrodes 206. A recessed portion 209 for engagement with the protrusion 76a of the retaining member 76 of the ink cartridge 71 is formed in a side wall 208 opposite to the side wall 205.

In the aforementioned structure employed, when the ink cartridge 71 is inserted with the ink supply port 74 located at the deep side and pushed against the plate spring 203 as shown in Fig. 12A, the slit portion 79 is restricted by the protruded piece 204. Hence, even in the case where a rotating force (the arrow A in Fig. 12A) is given by the plate spring 203 provided an offset position so that the ink supply port 74 side is turned downward, the posture of the ink cartridge is restricted to be parallel with the specified insertion/removal direction, that is, in a direction parallel with the vertical direction in this embodiment.

When the ink cartridge 71 is further pushed in against the urging force of the plate spring 203, the protrusion 75a of the retaining member 75 is dropped and fitted into the recessed portion 207 by the total elasticity of the retaining member 75 as shown in Fig. 12B. Also, the retaining member 76 is fitted into the recessed portion 209.

On the other hand, to remove the ink cartridge 71 from the carriage 200 for exchange or the like, when the retaining member

75 is pressed elastically toward the container body 72, the protrusion 75a of the retaining member 75 is separated from the recessed portion 207. Hence, when the ink cartridge 71 is pulled out in this condition, the ink cartridge 71 can be removed without bending force or the like acting on the ink supply needle 202.

Figs. 13 and 14 show an example of a flow passage formed in the container body 72 constituting the ink cartridge 71. The container body 72 is partitioned into upper and lower sections by a wall 80 which extends substantially horizontally and, more specifically, extends in such a manner that the ink supply port 74 side is located slightly lower.

A first ink chamber 81 is formed in the lower section region. The upper section is partitioned by a frame 84 such that the wall 80 serves as a bottom surface and that the frame 84 is spaced at a predetermined space, gap or distance from a wall 82 of the container body 72 to define an air communication passage 83. The interior of the frame 84 is divided by a vertical wall 85 having a communication port 85a formed in its bottom portion, so that one region is formed as a second ink chamber 86 and the other region is formed as a third ink chamber 87.

The second ink chamber 86 and the bottom surface 72a of container body 72 are connected to each other by a suction flow passage 88 which has a lower end communicated with the first ink chamber 81, and an upper end communicated with the bottom

portion of the second ink chamber 86.

A wall 89 having communication ports 89a and 89b is formed in the lower portion of the suction flow passage 88. An opening 90 for injecting ink from the outside into the container body 5 72 and an opening 91 communicated with the first ink chamber 81 for discharging air at the time of injection of ink or injecting ink into the interior of the ink cartridge 71 are formed in a region opposite to the lower end of the suction flow passage 88.

10 The third ink chamber 87 is partitioned by a wall 92 at a predetermined gap from the upper surface 84a of the frame 84 and by walls 94, 96 and 85. A fourth ink chamber 93 is partitioned by walls 94, 96 and 97. A filter chamber 104 is partitioned by the wall 94 continuous to the wall 92 for storing a filter 15 125 (Fig. 16); and a differential pressure valve-storing chamber 103 (Fig. 15A) is partitioned on the other surface side opposite to the filter chamber 125 by a wall 95. Through-holes 95a are provided through the wall 95 so that ink passed through the filter 125 is led to the differential pressure valve-storing chamber 20 103. The filter chamber 104 and the differential pressure valve-storing chamber 103 are located opposite each other with respect to the common wall 95.

The partition wall 96 having the communication port 96a between the walls 80 and 96 is provided in the lower portion

of the wall 94. The partition wall 97 having a communication port 97a in the lower portion is provided to define an ink flow passage 98 between the wall 97 and the frame 84. The upper portion of the ink flow passage 98 is communicated with the front surface 5 side of the ink cartridge 71 through the through-hole 99.

The through-hole 99 is separated by a wall 100 continuous to the wall 97 as shown in Fig. 14, and is communicated via a recessed portion 100a (Fig. 15A) of the wall 100 with the upper portion of the filter chamber 104. In more detail, the through-hole 10 99 is communicated with a region 101 partitioned by the walls 100, 94 and 92 through the recessed portion 100a and is further communicated with the upper portion of the filter chamber 104 through the communication port 94a formed in the upper portion of the wall 94 for partitioning the filter chamber 104.

15 As shown in Fig. 15A, the lower portion of the differential pressure valve-storing chamber 103 and the ink supply port 74 are connected to each other by a flow passage constituted by a recessed portion 105 formed in a surface of the container body 72, and an air-impermeable film covering the recessed portion 20 105. In Fig. 15A, the reference numeral 105a designates a deep portion which comes into the ink supply port side.

An narrow groove 106 which meanders so that flow path resistance is made as high as possible, a wide groove 107 around the narrow groove 106, and a rectangular recessed portion 108 in a region

opposite to the second ink chamber 86 are formed in the front surface of the container body 72. A frame 109 and ribs 110 are formed in the rectangular recessed portion 108 so as to be located in a position lowered by one step from an opening edge of the recessed portion 108. An air-permeable film having ink repellent property and air permeability is bonded to the frame 109 and the ribs 110 in a stretched state to thereby define an air communication chamber. The narrow groove 106 is communicated with a surface side region of the recessed portion 108 with respect to the air-permeable film. A through-hole 111 is formed in the bottom surface of the recessed portion 108, and communicated with one end of a slender region 113 (Fig. 13) partitioned by a wall 112 of the second ink chamber 86. The other end of the slender region 113 is communicated via a through-hole 114, a communication groove 115 and a through-hole 116 with the valve-storing chamber 78 as shown in Fig. 15B.

At a leading end of the valve-storing chamber 78 in the insertion direction of the ink cartridge, i.e. at the lower portion of the valve-storing chamber 78 in this embodiment, a window 78a is formed and opened as shown in Fig. 14. An identification block 140 to be described later is mounted to a recessed portion 150 of the container body 72 so that the plural identification pieces 210, 211 and 212 (Fig. 11) and the valve-operating rod, which are provided on the carriage 200 of the recording device

body, can enter through the window 78a.

Fig. 16 shows the sectional structure of vicinities of the differential pressure valve-storing chamber 103. A spring 120 and a membrane valve 122 are stored in the differential pressure valve-storing chamber 103. The membrane valve 122 is formed from an elastically deformable material such as elastomer or the like, and has a through-hole 121 in its center. The membrane valve 122 has an annular thick portion 122a provided in its circumference, and a frame portion 124 integral with the thick portion 122a. The membrane valve 122 is fixed to the container body 72 through the frame portion 124. The spring 120 has one end supported by a spring receiving portion 122b of the membrane valve 122, and the other end supported by a spring receiving portion 123a of a cover 123 for closing the chamber 103.

In Fig. 16, the reference numeral 125 designates a filter provided in the filter chamber 104; and 126 and 127, air-impermeable films stuck to the front surface of the container body 72 and the opening surface side thereof respectively. The film 126 is bonded to the frame 84 and the walls 80, 85, 92, 94, 96, 97, 100 and 112 as shown in Fig. 14, by welding or the like, so that the upper section ink chambers 86, 87 and 93 are formed.

In the aforementioned configuration, ink passing through the filter 125 passes through the ink flow ports 95a but is blocked by the membrane valve 122. When the pressure of the ink supply

port 74 is reduced in this condition, the membrane valve 122 is separated from the valve seat portion 95b against the urging force of the spring 120. Hence, the ink passes through the through-hole 121 and flows into the ink supply port 74 via the 5 flow passage formed by the recessed portion 105.

When the ink pressure of the ink supply port 74 is increased to a predetermined value, the membrane valve 122 is moved by the urging force of the spring 120. Hence, the membrane valve 122 is brought into elastic contact with the valve seat portion 10 95b; so that a flow of ink is blocked. When the aforementioned operation is repeated, ink can be supplied into the ink supply port 74 while the ink pressure is kept at a constant negative pressure value.

Fig. 17 shows the sectional structure of the air communication valve-storing chamber 78. A through-hole 130 is formed in a wall partitioning the valve-storing chamber 78. A pressing member 131 formed from an elastic member such as rubber is movably inserted into the through-hole 130 while the periphery of the pressing member 131 is supported by the container body 72. A valve body 20 135 is supported by an elastic member such a leaf spring 132 having a lower end fixed by a protrusion 133 and a center portion restricted by a protrusion 134, so that the valve body 135 is always urged toward the through-hole 130. The valve body 135 is disposed at the entering side front end of the pressing member

131.

The identification block 140 as shown in Figs. 18A to 18C is attached to the container body 72 so that the identification block 140 is located adjacent to the air communication valve-storing chamber 78 and that the pressing member 131 of the valve member 135 can be displaced. The identification block 140 has a base body that is fixed to the recessed portion 150 (Fig. 15A) of the container body 72 by claws 140a and 140b. The base body of the identification block 140 is formed with a plurality of grooves (for example, three grooves 141, 142 and 143 in this embodiment), each parallel with the insertion direction of the ink cartridge 71 and having a predetermined width in the width direction of ink cartridge 71. Further, an arm 144 for displacing the pressing member 131 is integrally formed in a predetermined position within a specific one of the grooves (within the groove 142 in this embodiment).

An opening portion is widened as indicated by D on the identification piece-entrance side (lower portion in Figs. 18A to 18C) of the groove 142 in which the arm 144 is disposed, so that the opening portion of the groove 142 is integrated with one of adjacent grooves (for example, the groove 141 in this embodiment). Hence, even in the case where the position of the operating rod 213 (Fig. 21) changes slightly when the ink cartridge 71 is attached to the carriage 200, the operating rod 213 can

be received and guided by the wide opening portion D so as to enter the groove 142.

The arm 144 can be rotated about a rotational fulcrum 144a so as to be located slightly inward. The arm 144 is formed so 5 that the pull-out side, i.e. the upper side in this embodiment, of the arm 144 is protruded obliquely into the entrance path of the operating rod 213 (Fig. 21). Further, identification protruded portions 141a, 142a and 143a are formed in the grooves 141 to 143 respectively so as to be opposite to leading ends 10 of the identification pieces 210, 211 and 212 of the carriage 200.

With the aforementioned configuration, the position of the arm 144 is kept constant, and the positions of the protruded portions 141a, 142a and 143a are changed within the grooves 141, 15 142 and 143 respectively as shown in Figs. 19A and 19A' through Figs. 19F and 19F'. Further, the positions of leading ends of the identification pieces 210, 211 and 212 are set correspondingly in accordance with the protruded portions 141a, 142a and 143a 20 of the ink cartridge 71 allowed to be attached. As a result, the ink cartridge 71 storing incompatible ink therein can be prevented from being attached to the carriage 200.

Because the positions of the protruded portions 141a, 142a and 143a can be changed not only in the insertion/removal direction of the ink cartridge 71 but also in the thickness direction of

the ink cartridge 71, the protruded portions 141a, 142a and 143a can be arranged three-dimensionally. Accordingly, a lot of kinds of ink can be identified without enlargement of the identification region-forming area. If the depth of each groove 141, 142 and 143 (a length in the thickness direction of the container body 2) is set to be such a size that a plurality of identification pieces 210, 211, 212 can be inserted into each groove, a larger number of kinds of ink can be identified.

Figs. 20 and 21 show an embodiment of the carriage to which ink cartridges are attached. A plurality of ink cartridges can be attached. This embodiment is configured so that one black ink cartridge and three color ink cartridges can be attached. The color, as with all of the embodiments, may include dense and light inks (e.g., dense cyan and light cyan), and clear ink.

That is, a first attachment region 220 which is slightly wider is provided on one side. Second, third and fourth attachment regions 221 to 223 which have the same width are partitioned by ribs 224 to 226 and ribs 227 to 229 at opposite ends so as to be adjacent to the first attachment region 220.

As described above with reference to Fig. 11, each of the ink cartridge attachment regions has an ink supply needle 202 communicated with a recording head 201, a pressing member, i.e. a leaf or plate spring 203 in this embodiment, provided in a region far from the region in which the ink supply needle 202

is provided, and a positioning protruded piece 204 formed between the leaf spring 203 and the ink supply needle 202 so as to extend in the insertion/removal direction of the ink cartridge.

Further, electrodes 206 are disposed on a side wall 205 5 on the ink supply needle 202 side. Recessed portions 207 fitted to the protrusions 75a of the retaining members 75 are formed above the electrodes 206.

In this embodiment, the positioning protruded piece 204 is formed with a side portion 204a extending in parallel with 10 the front surface of the ink cartridge 71 as shown in Fig. 22A to ensure the reliable positioning of the ink cartridge and reinforce the strength of the thin and long protruded piece 204.

In order to cope with this structure, the leading end of the slit portion 79 of the ink cartridge 71 in the insertion direction 15 of the ink cartridge 71 is extended to the front surface side while a recessed portion 79a is formed at least in a region opposite to the side portion 204a as shown in Figs. 9A, 10B and 22B.

That is, at least the cartridge insertion leading end of the slit portion 79 is formed with the recessed portion 79a to present 20 a substantially L-shape in section to match with the protruded piece 204 and the side portion 204a.

A pair of ribs 74a, 74a, each U-shaped in section are formed in the ink cartridge 71 to interpose the ink supply port 74 therebetween as shown in Fig. 22B, whereas mating ribs 202a for

engagement with the ribs 74a, 74a are formed around the ink supply needle 202 (Fig. 22A). These ribs can keep the ink supply needle 202 in a state in which the ink supply needle 202 is inserted into the ink supply port 74.

When the ink cartridge 71 is attached to the carriage 200 configured as described above, the identification pieces 210, 211 and 212 of the carriage 200 enter the grooves 141, 142 and 143 respectively in the identification block 140. Further, the operating rod 213 enters the groove 142. When the ink cartridge 71 is suitable to the attachment region, the ink supply port 74 of the ink cartridge 71 is moved to a position where the ink supply port 74 can be fitted to the ink supply needle 202. In this process, the operating rod 213 presses the arm 144 of the identification block 140 to thereby open the valve member 135 of the air communication valve-storing chamber 78. Hence, the first ink chamber 81 of the ink cartridge 71 is communicated with the air so that ink can be supplied to the recording head as described above.

On the other hand, when an ink cartridge not suitable for the attachment region is attached, any one of the identification protruded portions 141a, 142a and 143a in the grooves 141, 142 and 143 of the identification block 140 collides with any one of the identification pieces 210, 211 and 212 of the carriage 200, to thereby inhibit the movement of the ink cartridge 71

before the ink supply port 74 is fitted to the ink supply needle 202. Hence, the mistaken attachment can be found before the ink supply port 74 is fitted to the ink supply needle 202 and before the operating rod 213 presses the arm 144 of the 5 identification block 140.

The function of the identification block will be described in detail.

Assuming, for example, that three identification piece insertable regions, i.e. three grooves 141, 142 and 143 are prepared 10 as in the case of the identification block 140 shown in Figs. 19A and 19A' through Figs. 19F and 19F', and that the number of identifiable regions, i.e. the number of coordinate points, in each of the insertable regions, is three as shown in Fig. 18C, 27 different patterns can be set for identification as shown 15 in Table 1.

20

[Table 1]

pattern	a	b	c
1	1	1	1
2	1	1	2

3	1	1	3
4	1	2	1
5	1	2	2
6	1	2	3
7	1	3	1
8	1	3	2
9	1	3	3
10	2	1	1
11	2	1	2
12	2	1	3
13	2	2	1
14	2	2	2
15	2	2	3
16	2	3	1
17	2	3	2
18	2	3	3
19	3	1	1
20	3	1	2
21	3	1	3
22	3	2	1
23	3	2	2
24	3	2	3
25	3	3	1

26	3	3	2
27	3	3	3

Incidentally, in Table 1, the reference characters a, b and c designate three identification piece insertable regions (i.e., the grooves 141, 142 and 143 in this embodiment), and the numerical values 1, 2 and 3 designate the relative positions of the identification pieces in the insertion/removal direction of the cartridge (i.e., the coordinate points 1 to 3 in Fig. 18C).

In the aforementioned embodiment, the arm 144 for displacing the pressing member 131 of the air opening valve is disposed on the frontmost end side in one of the identification piece insertable regions, that is, in the groove 142. Therefore, the coordinate points which can be set in the groove 142 are two. Hence, in this case, 18 patterns can be set for identification as shown in Table 2. That is, in this case, as shown in Table 2, the coordinate point 3 can not be set in the insertable region b.

[Table 2]

pattern	a	b	c
1	1	1	1
2	1	1	2

3	1	1	3
4	1	2	1
5	1	2	2
6	1	2	3
7	1	X	1
8	1	X	2
9	1	X	3
10	2	1	1
11	2	1	2
12	2	1	3
13	2	2	1
14	2	2	2
15	2	2	3
16	2	X	1
17	2	X	2
18	2	X	3
19	3	1	1
20	3	1	2
21	3	1	3
22	3	2	1
23	3	2	2
24	3	2	3
25	3	X	1

26	3	X	2
27	3	X \	3

As to the configuration of each of the identification pieces 210, 211 and 213 for the aforementioned identification block 5 140, the following three patterns are conceivable as shown in Figs. 23A to 23C:

pattern A in which the relative height H is 1 and the relative length L of the deep side of the groove is 3;

10 pattern B in which the relative height H is 2 and the relative length L of the deep side of the groove is 2 or pattern B' in which the relative height H is 2, the relative length L₁ of the lower deep side of the groove is 2 and the relative length L₂ of the upper deep side of the groove is 1; and

15 pattern C in which the relative height H is 3 and the relative length L of the deep side of the groove is 1.

Selected one of these patterns A to C is used as each of the identification pieces 210, 211 and 213 to correspond to a respective one of the grooves 141, 142 and 143. This makes it possible to identify 18 different types of cartridges one from 20 the others. With specific reference to FIG. 23A, there is shown an exemplary illustration of an end portion E1 of an identification piece in a first direction, an end portion E2 of the identification piece in a second direction, and a location where the identification piece is formed E3 in a third direction.

25 In addition, in case of identification piece patterns as shown in Figs. 23D to 23F, since these patterns are smaller than the patterns A to C and thus can enter the grooves designed for

identifying the patterns A to C, an unsuitable ink cartridge cannot be excluded surely. However, these patterns may be used if an appropriate pattern combination is applied.

Further, in each of the identification block grooves 141, 5 142 and 143, not only the protruded portion (141a in Figs. 24A to 24C) for restricting the relative height of the identification piece pattern but also a portion (141b in Figs. 24A to 24C) for restricting the relative length of the identification piece pattern are provided to correspond to the selected one of the identification 10 piece patterns A to C. That is, the coordinate points (141b in Figs. 24A to 24C) represented by cross hatching are also restricted so that the depth of the identification block groove 141, 142, 143 is set to have a relative length L' of 3 for the pattern A, a relative length L' of 2 for the patterns B and B' 15 and a relative length L' of 1 for the pattern C. This makes it possible to surely identify the three kinds of patterns A to C one from the other with the groove 141, 142, 143. Accordingly, the ink cartridge 71 can be prevented from being inserted by mistake. (In addition, in this case, since the identification 20 piece pattern B and the identification piece pattern B' are different in shape from each other, but can be properly inserted into the same identification block groove, either one of the patterns B and B' can be used in combination with the other patterns A and C. That is, in this case, the pattern B cannot be distinguished

from the pattern B').)

Similarly, in case where four grooves are provided to the identification block 140, each of the grooves 141, 142 and 143 is set to have a relative length of 4 in the depth direction 5 and a relative height of 4 in the cartridge insertion/removal direction. As to the corresponding identification pieces, as shown in Figs. 25A to 25D, there are prepared:

pattern E in which the relative height H is 1 and the relative length L is 4;

10 patterns F to F" in which the relative height H is 2 and the relative length L is 3;

patterns G to G" in which the relative height H is 3 and the relative length L is 2; and

15 pattern J in which the relative height H is 4 and the relative length L is 1.

Hence, as described above, by restricting at least the relative height H' and the relative length (depth) L' of the groove as shown by cross hatching in Figs. 26A to 26D, the identification pieces can be identified one from the other.

20 That is, if a number N (N is an integer not smaller than 3) of coordinate points are provided in each of the directions parallel to the insertion direction of the ink cartridge and the depth direction of the ink cartridge, the identification pieces may be preferably formed so that:

the first pattern identification piece has an end portion that reaches the first coordinate point in a coordinate axis direction parallel with the insertion direction of the ink cartridge, and an end portion that reaches the n-th coordinate point in a coordinate axial direction parallel to the depth of the ink cartridge;

the i-th (i is an integer satisfying the relation $2 \leq i \leq (n - 1)$) pattern identification piece has an end portion that reaches the i-th coordinate point in the coordinate axis direction parallel with the insertion direction of the ink cartridge, and an end portion that reaches the $(n - i + 1)$ -th coordinate point in the coordinate axis direction parallel to the depth of the ink cartridge; and

the n-th pattern identification piece has an end portion that reaches the n-th coordinate point in the coordinate axis direction parallel with the direction of insertion of the ink cartridge, and an end portion that reaches the first coordinate point in the coordinate axis direction parallel to the depth of the ink cartridge.

Incidentally, the ink cartridge 71' (Fig. 27A to C) attached to the wide attachment region 220 is basically the same in structure as the ink cartridges 71 attached to the second to fourth attachment regions 221, 222, 223 and shown in Figs. 10 through 17. As shown in Fig. 27, the container body 72' of the ink cartridge 71' is

however formed so that the shape of the opening surface is not changed but only the depth W is increased. Hence, the quantity of ink allowed to be stored in the ink cartridge 71' can be increased by simply changing the depth W of the container body 72'.

5 The arrangement center of the ink supply port 74' and the memory device 77' is set to be located at a constant position W1 from the front surface, i.e. the closed side, of the container body 72' in the same manner as in other exemplary ink cartridges 71. Because the identification block 140' (Fig. 28A and B) is attached to the front surface side of the container body 72', it is a matter of course that the distance of the identification block 140' from the front surface of the container body 72' is the same as those in the other ink cartridges 71.

15 The retaining member 75' is located offset to the side of the container body 72' in the same manner as the offset location of the ink supply port 74' as shown in Fig. 27C so that pressing force surely acts on the ink supply port 74' at the time of attachment of the ink cartridge 71'.

A decorative film 230 may be further bonded to the container body 72, 72' as shown in Figs. 28A. The decorative film 230 may be formed with a tongue portion 230a in a region corresponding to ink injection ports 90, 90', 91, 91' so that the ink injection ports 90, 90', 91, 91' are sealed with the tongue portion 230a as shown in Fig. 28B.

Although in the aforementioned embodiment the identification protruded portions are integrally formed in the identification block, the present invention may be applied also to the case where holes are formed in the identification block and pins are inserted into the holes. For example, holes are arrayed in the height direction in each identification piece insertable groove, and a pin is inserted into a selected one of the holes to extend at least partially across the groove, to thereby constitute the height restricting portion. Of course, holes may be arrayed in the depth direction. Further, a protruded length of each pin may be selected appropriately.

Although in the aforementioned embodiment a plurality of grooves are formed in the identification block so that the identification protruded portions are formed in the grooves, the same effect as described above can be obtained even in the case where the identification block is formed as a block 220 having recessed portions coincident with the external shapes of the identification pieces A, B and C as shown in Fig. 29. In this case, if a gap, through which the operating rod 213 can enter for opening the valve member 135, is formed between the block 220 and the ink cartridge 71, or if a recessed portion or a through-hole may be formed in the block per se, the block can be disposed near the valve member.

If the identification block need not be disposed near the

opening/closing valve member, identification pieces constituted by protruded pieces may be provided to the container constituting the ink cartridge, and the identification block may be attached and fixed to a corresponding place of the carriage.

5 Further, the identification pieces/the identification block and the memory device of the ink cartridge may be used in combination for identification of the ink cartridge. Between ink cartridges that do not cause attachment error, the ink cartridge may be judged, based on information stored in the memory device, as 10 to whether the ink cartridge is adaptable or not.

Further, the identification fitting portions (the identification protruded portions) need not abut against the identification pieces. That is, a clearance may be set between the fitting portion and the identification piece to such a degree 15 that one identification piece can be discriminated from another identification piece.

Although the aforementioned embodiment uses the differential pressure valve as a negative pressure generating mechanism, the same effect as described above can be obtained even in the case 20 where a porous member such as sponge is impregnated with ink so that negative pressure is kept by the capillary force of the fine pores of the porous member.

The kind of ink or item(s) to be identified includes at least one of an ink color, a type of colorant and a type of solvent.

As described above, in accordance with the present invention, a space is used such that identification limiting portions are disposed three-dimensionally. Hence, the number of combinations for identification purpose is increased, and therefore various 5 kinds of ink cartridges adapted to the recording device can be attached without mistake.

CLAIMS

What is claimed:

1. An ink-jet recording device for supplying ink to a recording head from at least one ink cartridge having a bottom wall, and first and second side walls connected to each other through the bottom wall and facing each other, the ink cartridge further having an ink supply port at the bottom wall, a first retaining member extending from the first side wall and a recess provided in the vicinity of the second side wall, the retaining member having a first engagement portion displaceable toward and away from the first side wall, the recording device comprising:
 - a carriage having at least one ink cartridge mounting region adapted to receive the ink cartridge;
 - a plurality of one identification members that are protruded from a bottom of the ink cartridge mounting region in a direction parallel to an insertion direction of the ink cartridge into the carriage, and that are positioned and configured so that the identification members are received by the recess of the ink cartridge when the ink cartridge is compatible to the ink cartridge mounting region;
 - an ink supply needle positioned in the bottom of the ink cartridge storage region and configured for connection to the ink supply port of the ink cartridge; and
 - a first engagement portion positioned and configured to engage the engagement portion of the ink cartridge.
2. The recording device according to claim 1, wherein the ink cartridge has a second retaining member extending from the second side wall, being located above the recess and having a second engagement portion displaceable toward and away from the second side wall,

and the recording device further comprises a second engagement portion positioned and configured to engage the second engagement portion of the ink cartridge.

3. The recording device according to claim 1, further comprising:

electric contacts positioned below the first engagement portion of the recording device and configured to electrically contract electrodes located at the first side wall of the ink cartridge.

4. An ink cartridge comprising:

a bottom wall, and first and second side walls connected to each other through the bottom wall and facing each other;
an ink supply port at the bottom wall
a first retaining member extending from the first side wall, the retaining member having a first engagement portion displaceable toward and away from the first side wall; and
a recess provided in the vicinity of the second side wall.

5. The ink cartridge according to claim 4, further comprising:

a second retaining member extending from the second side wall, being located above the recess and having a second engagement portion displaceable toward and away from the second side wall.

6. The ink cartridge according to claim 4, further comprising:

electrodes located at the first side wall and below the first retaining member.

7. The recording device according to claim 2, further comprising:
electric contacts positioned below the first engagement portion of the recording device and configured to electrically contract electrodes located at the first side wall of the ink cartridge.
8. The ink cartridge according to claim 5, further comprising:
electrodes located at the first side wall and below the first retaining member.

ABSTRACT

An ink-jet recording device for supplying ink to a recording head from at least one ink cartridge having a bottom wall, and first and second side walls connected to each other through the bottom wall and facing each other, the ink cartridge further having an ink supply port at the bottom wall, a first retaining member extending from the first side wall and a recess provided in the vicinity of the second side wall, the retaining member having a first engagement portion displaceable toward and away from the first side wall. The recording device comprises a carriage having at least one ink cartridge mounting region adapted to receive the ink cartridge, a plurality of one identification members that are protruded from a bottom of the ink cartridge mounting region in a direction parallel to an insertion direction of the ink cartridge into the carriage, and that are positioned and configured so that the identification members are received by the recess of the ink cartridge when the ink cartridge is compatible to the ink cartridge mounting region; an ink supply needle positioned in the bottom of the ink cartridge storage region and configured for connection to the ink supply port of the ink cartridge, and a first engagement portion positioned and configured to engage the engagement portion of the ink cartridge.

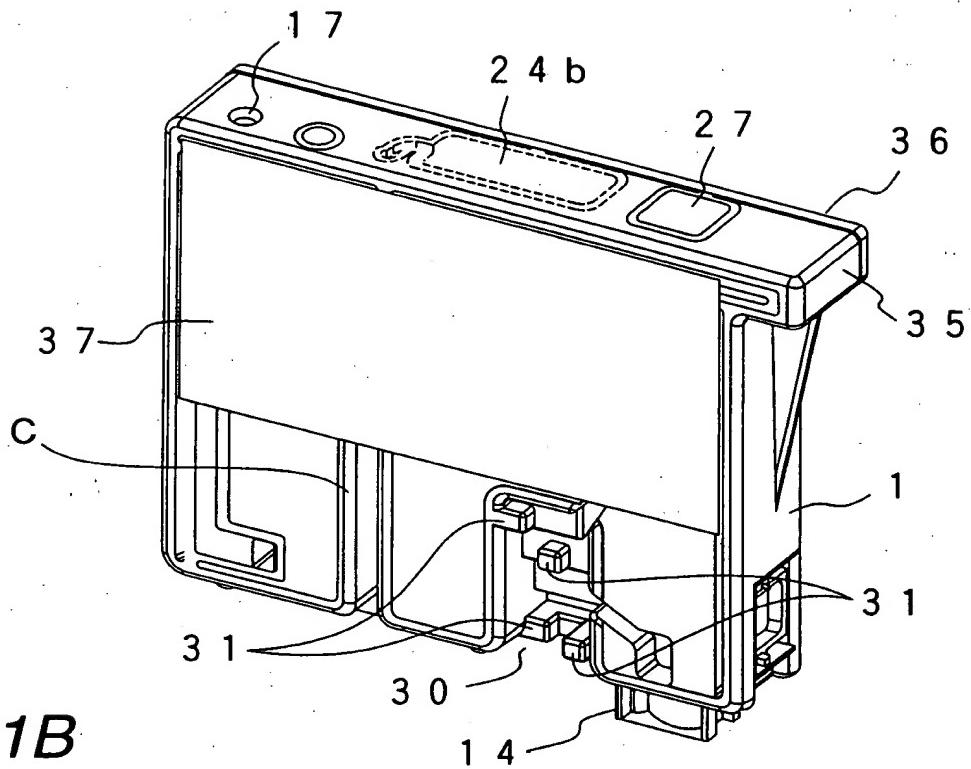
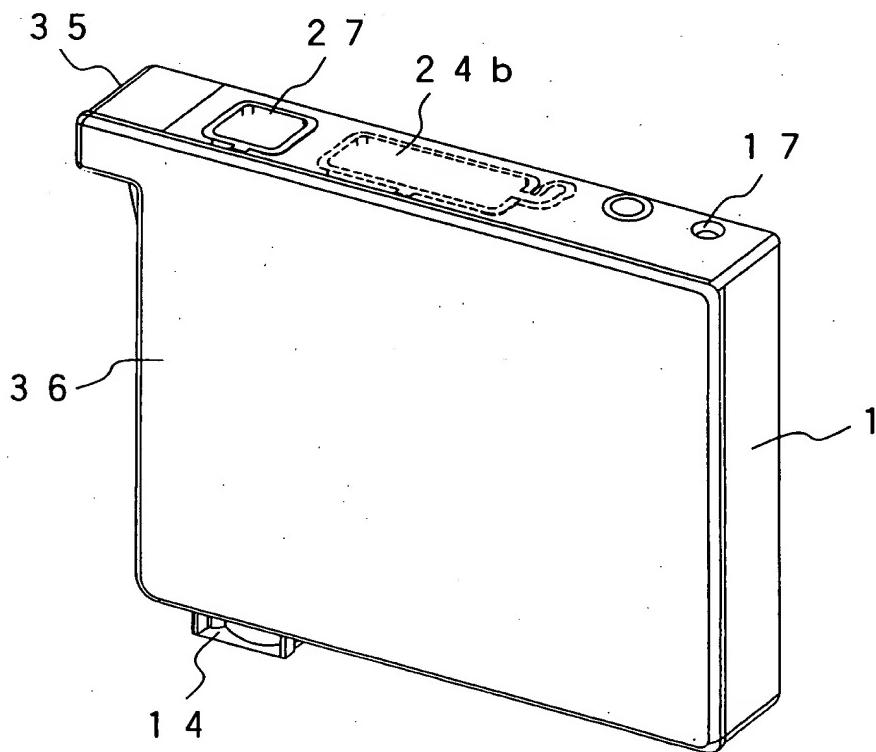
FIG. 1A**FIG. 1B**

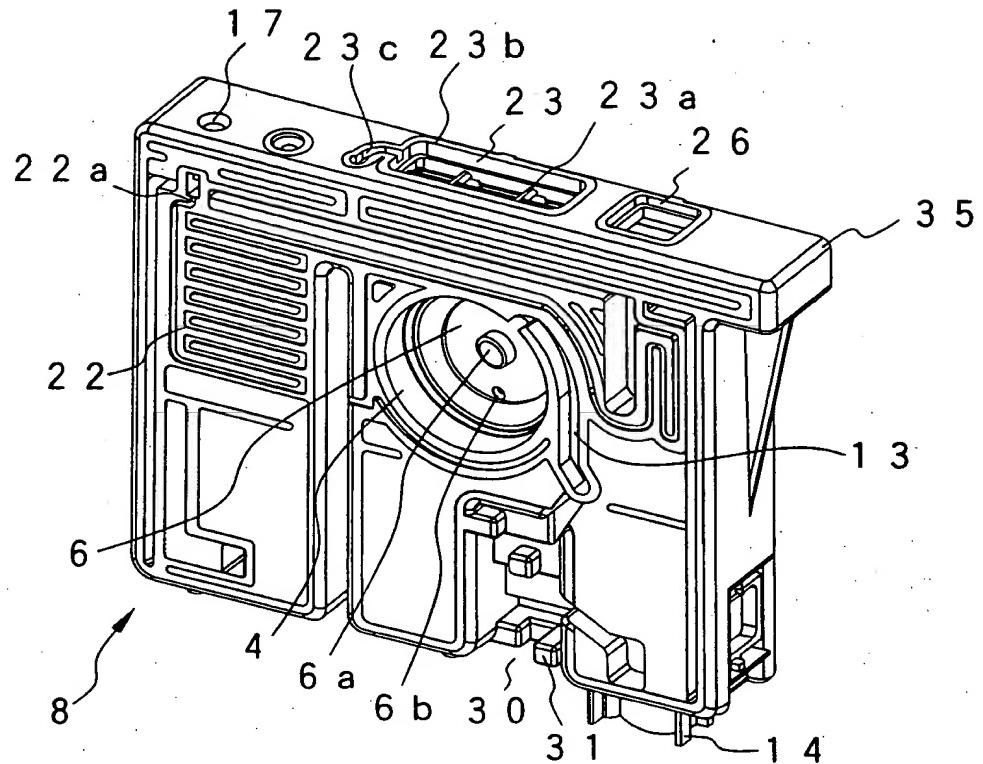
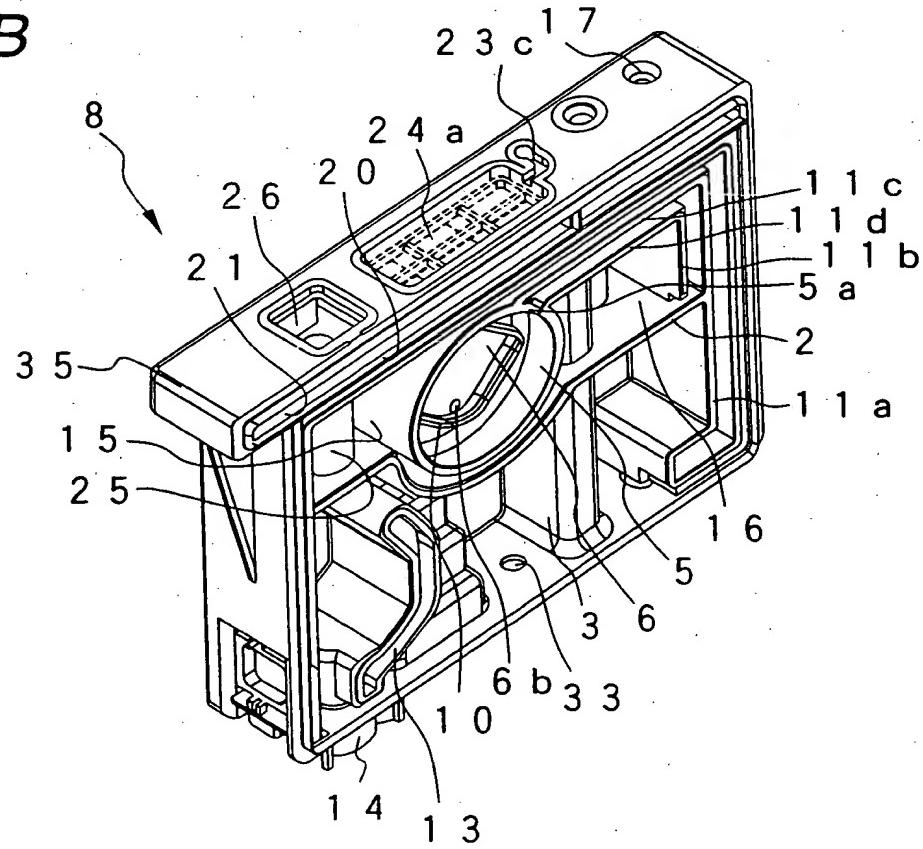
FIG. 2A**FIG. 2B**

FIG. 3

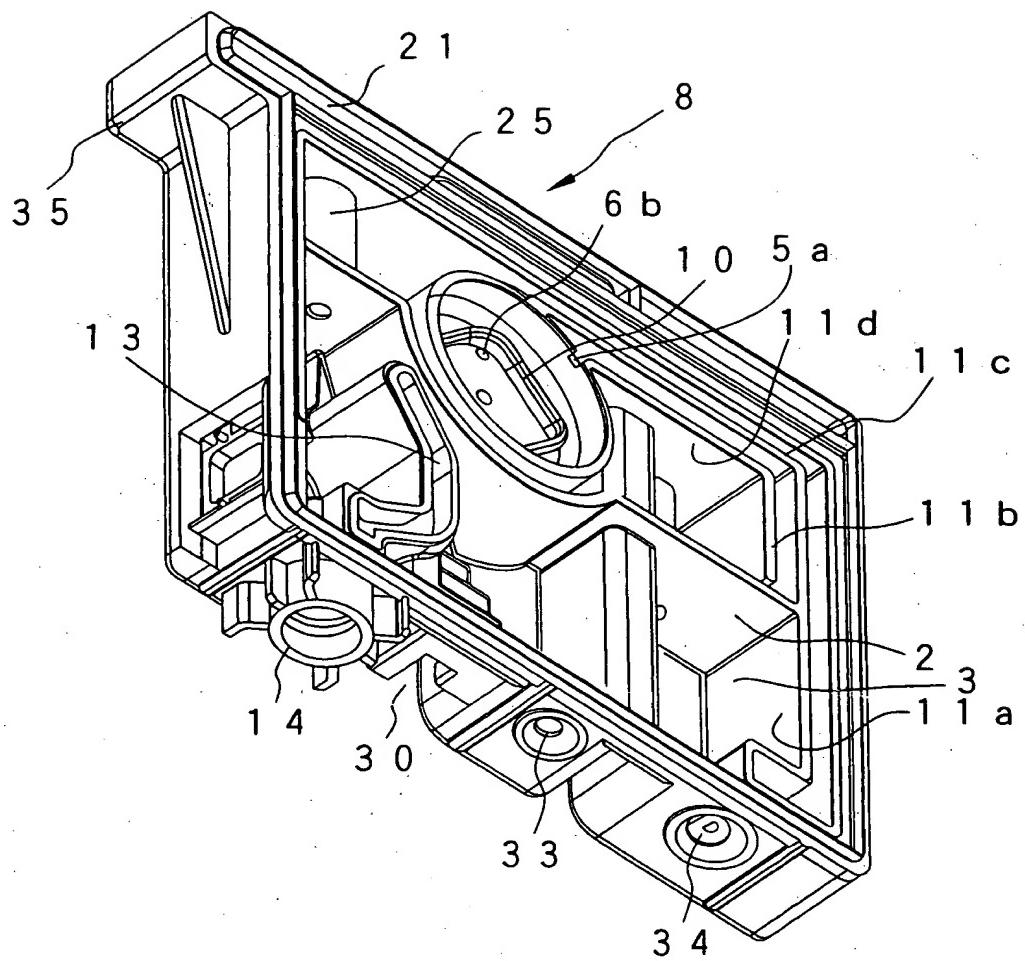


FIG. 4

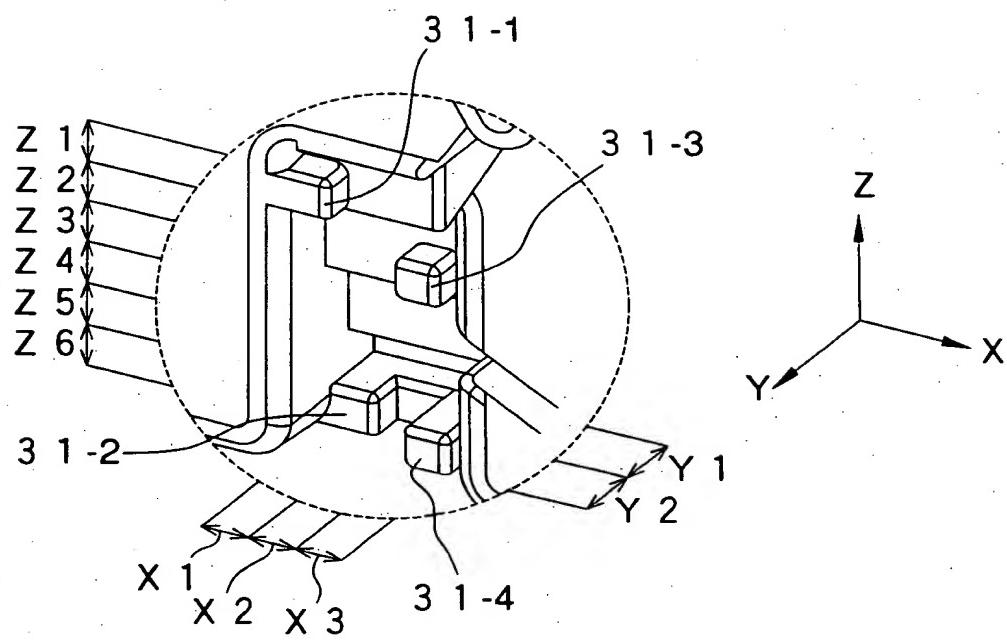


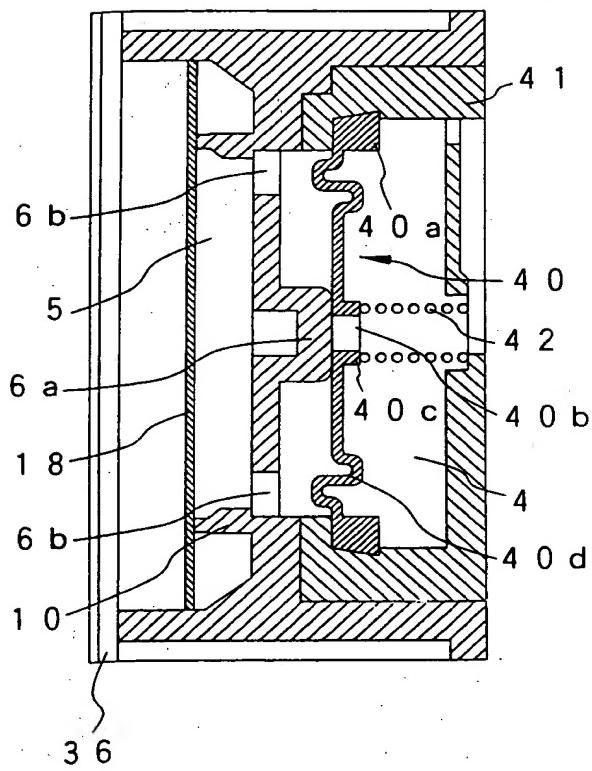
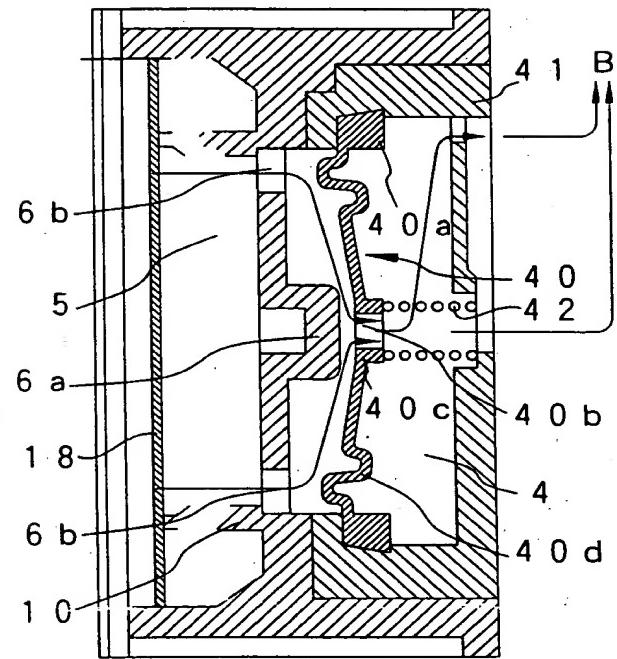
FIG. 5A**FIG. 5B**

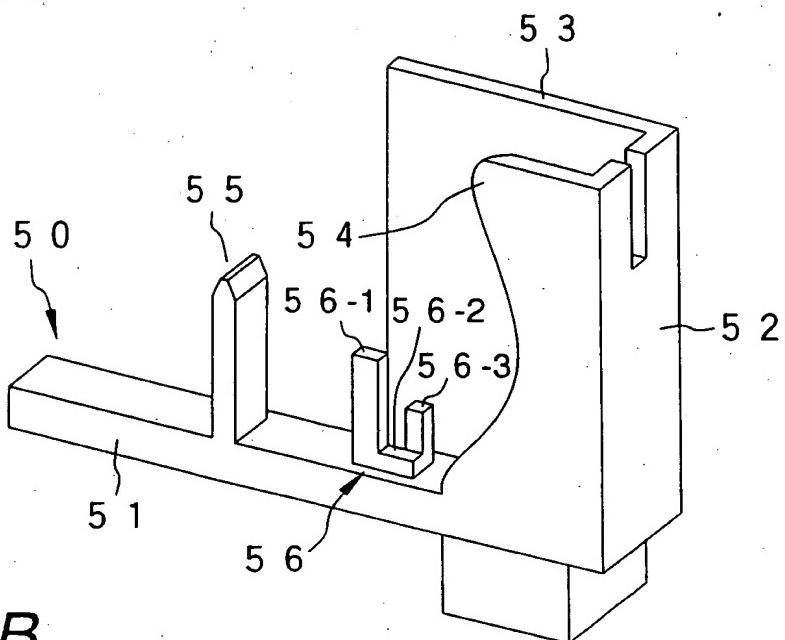
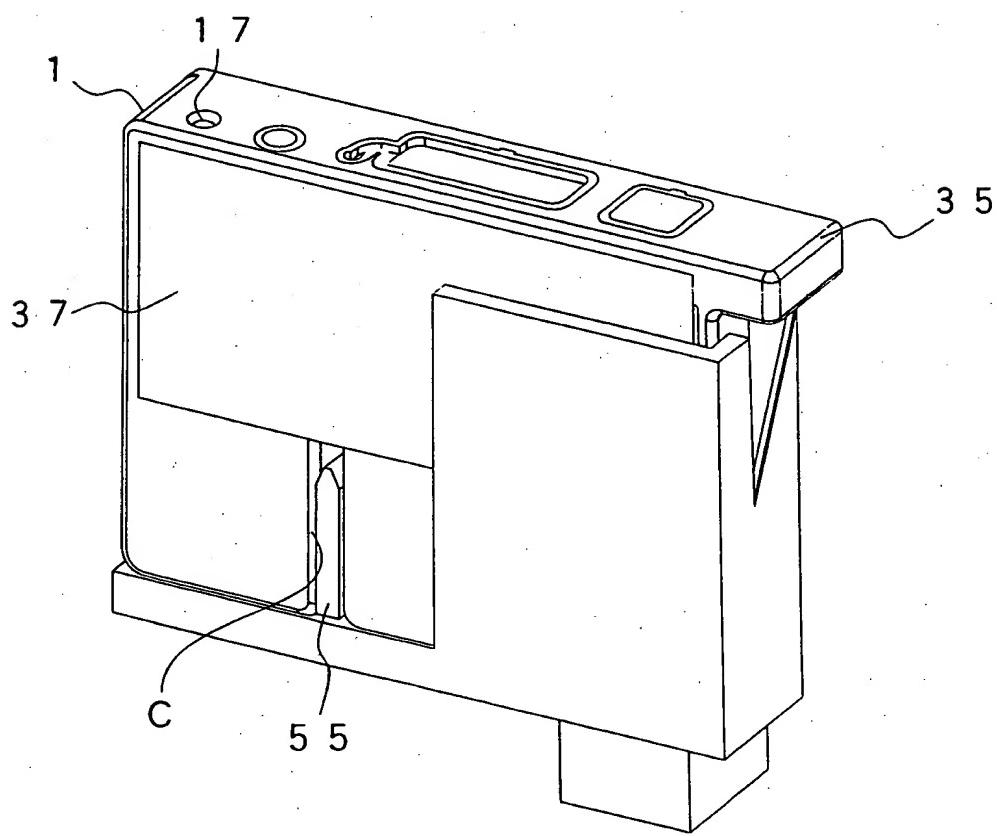
FIG. 6A**FIG. 6B**

FIG. 7

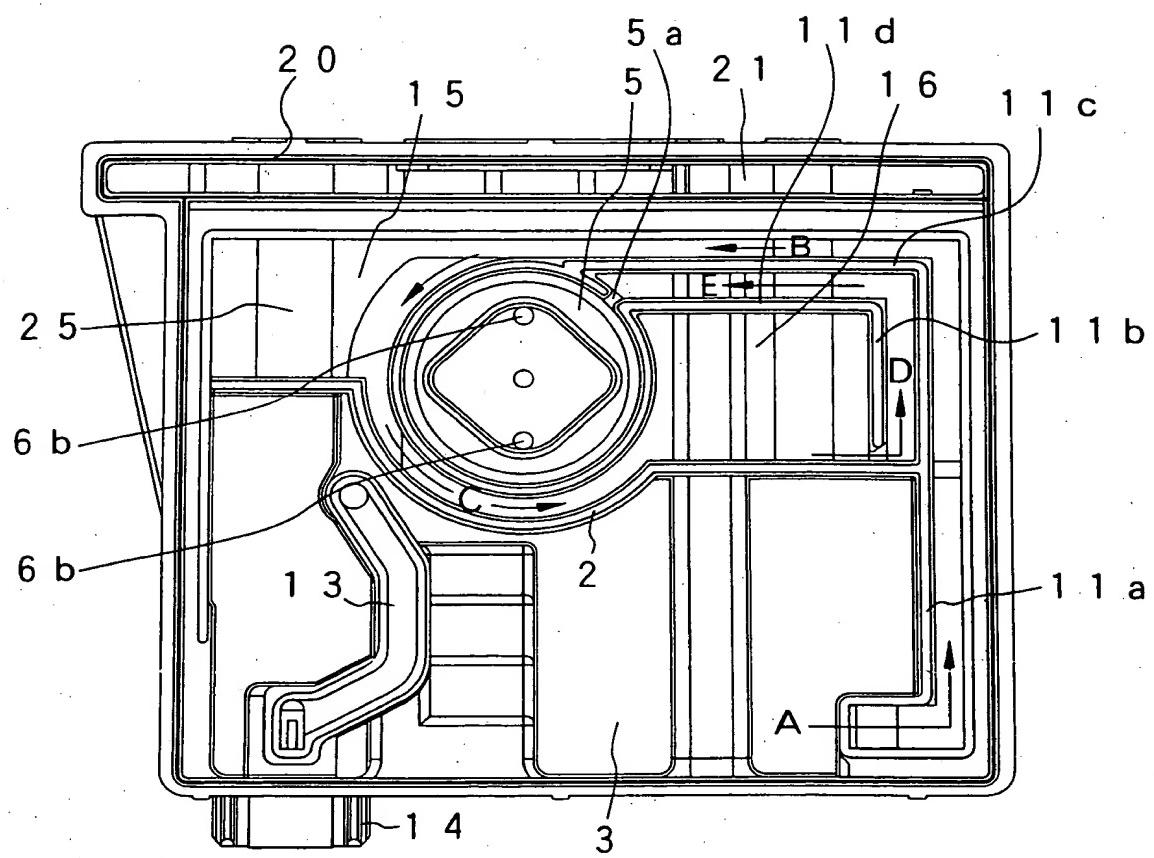


FIG. 8

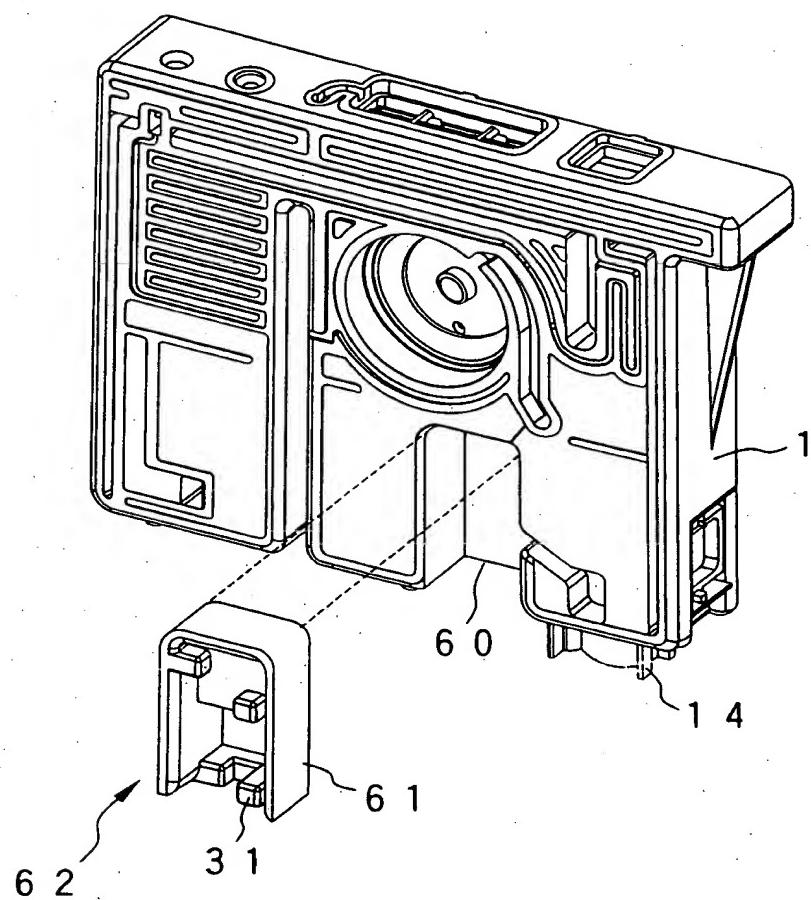
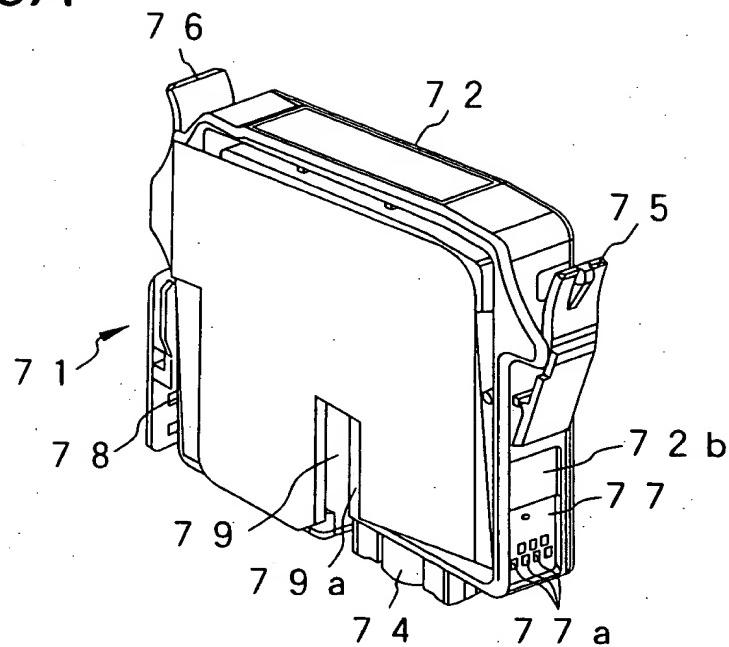
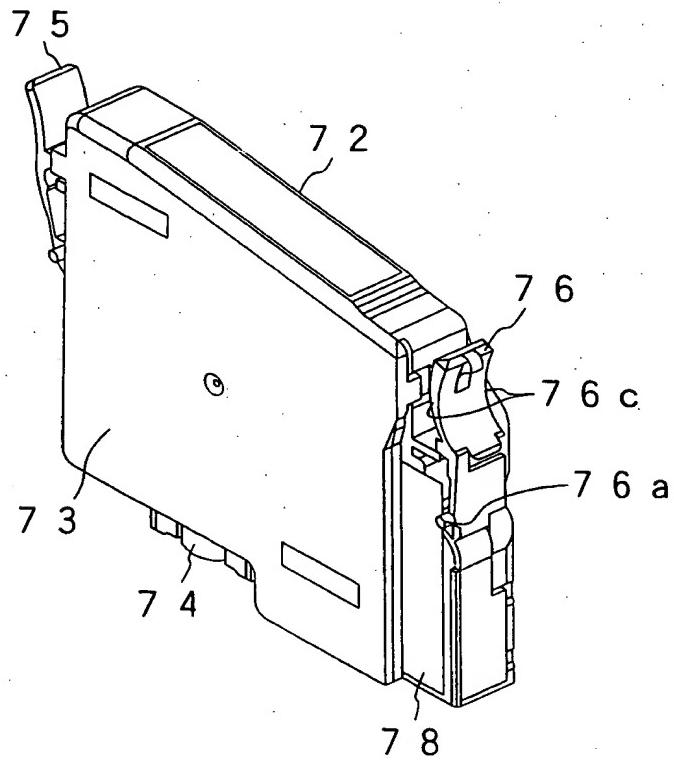


FIG. 9A**FIG. 9B**

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FIG. 10A

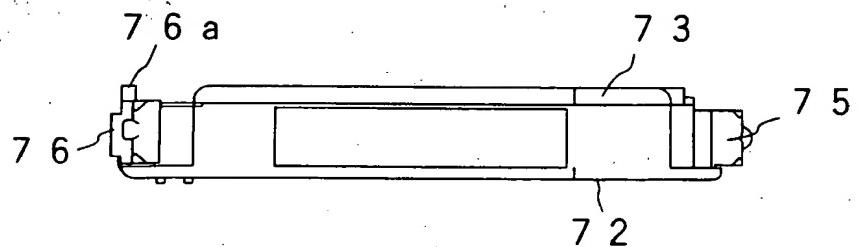


FIG. 10B

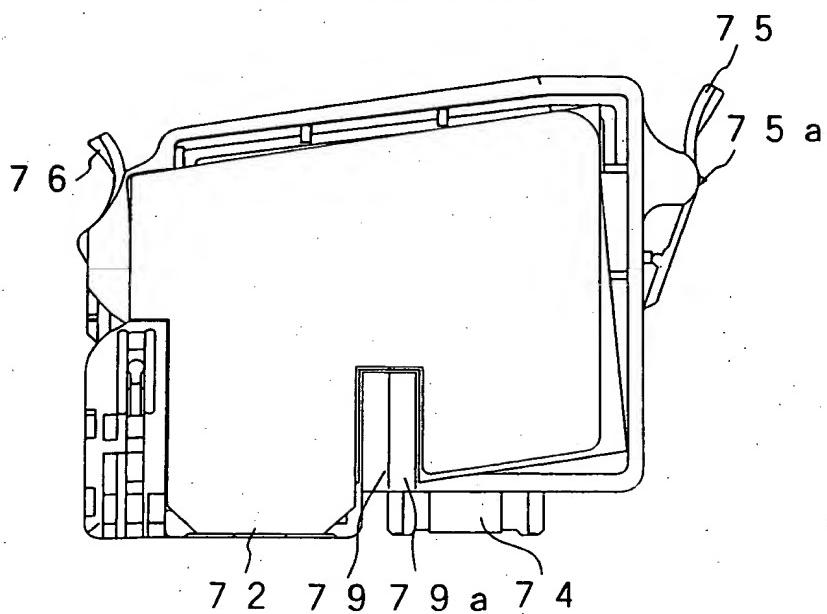


FIG. 10D

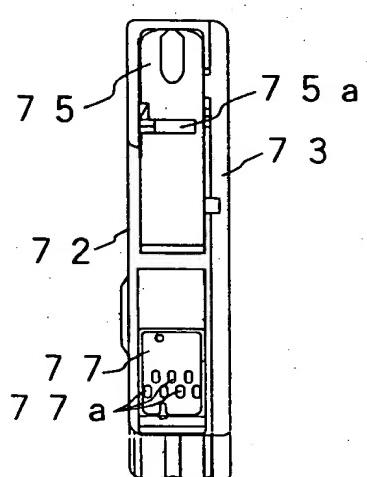
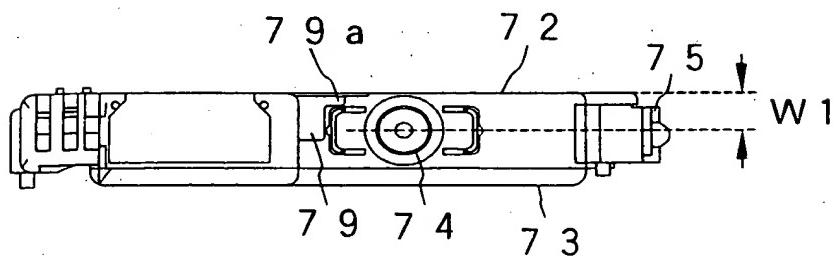


FIG. 10C



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FIG. 11

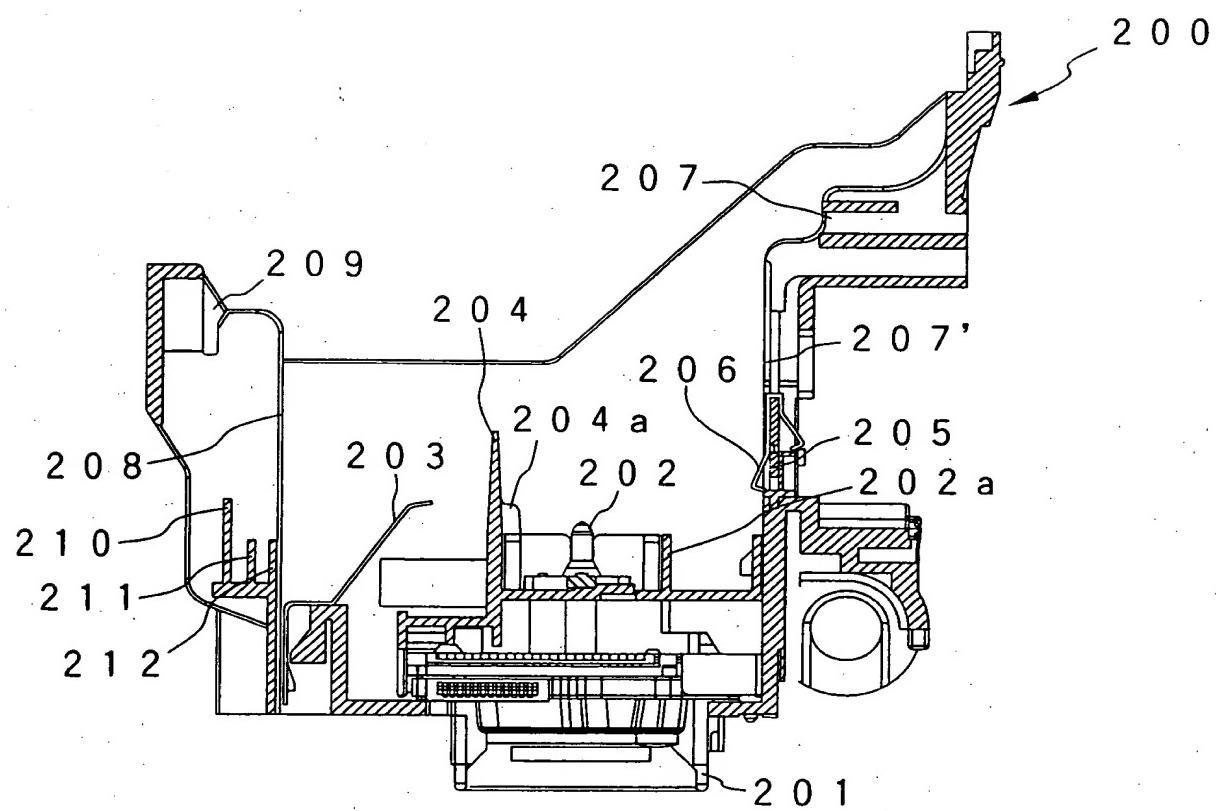


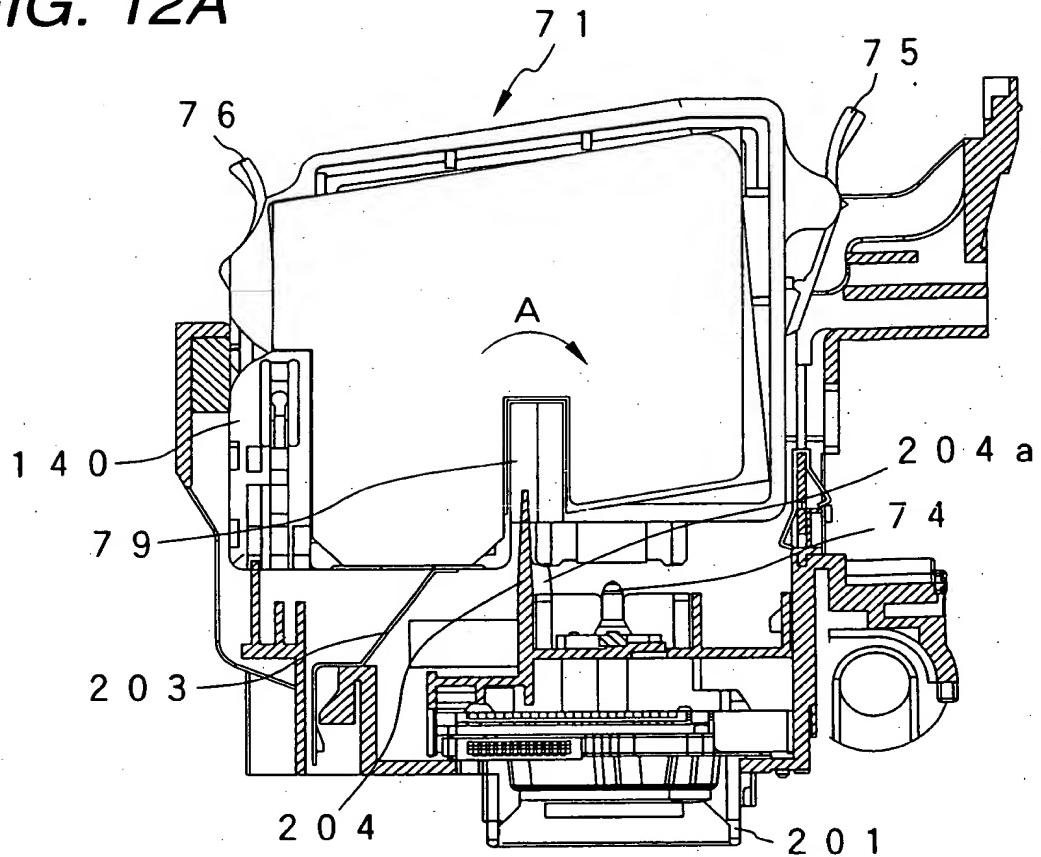
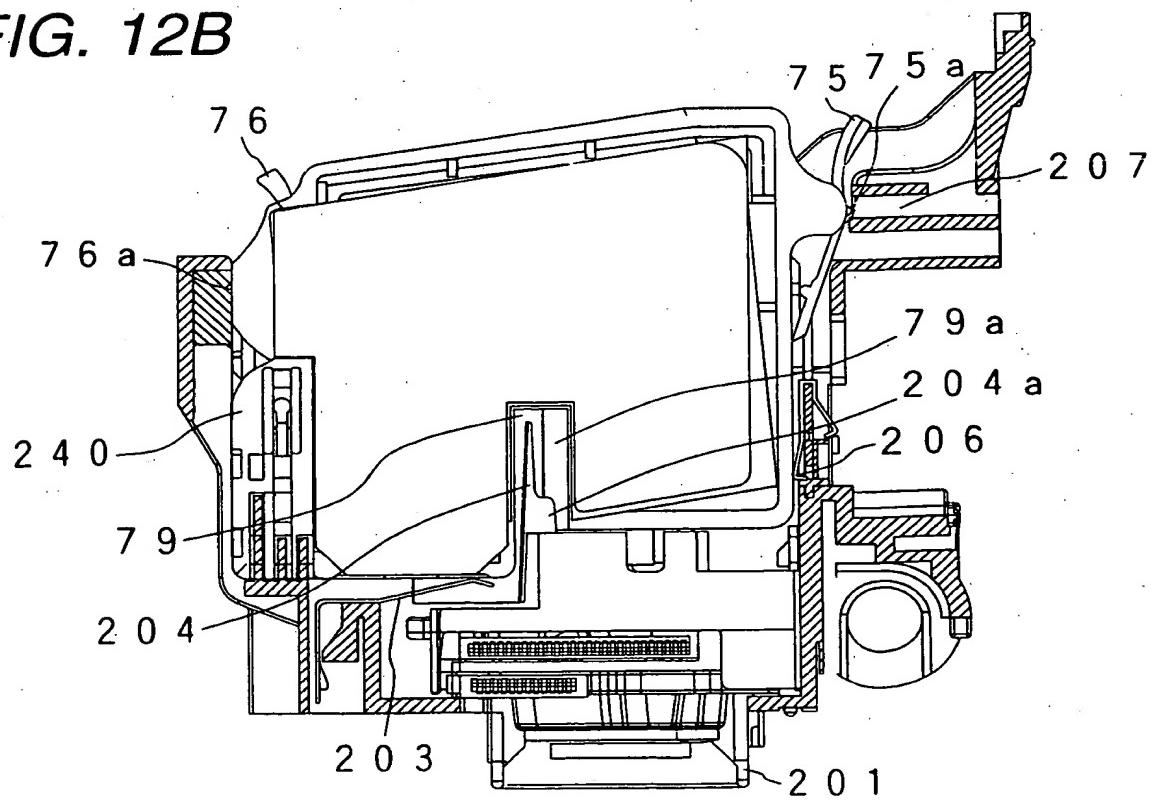
FIG. 12A**FIG. 12B**

FIG. 13

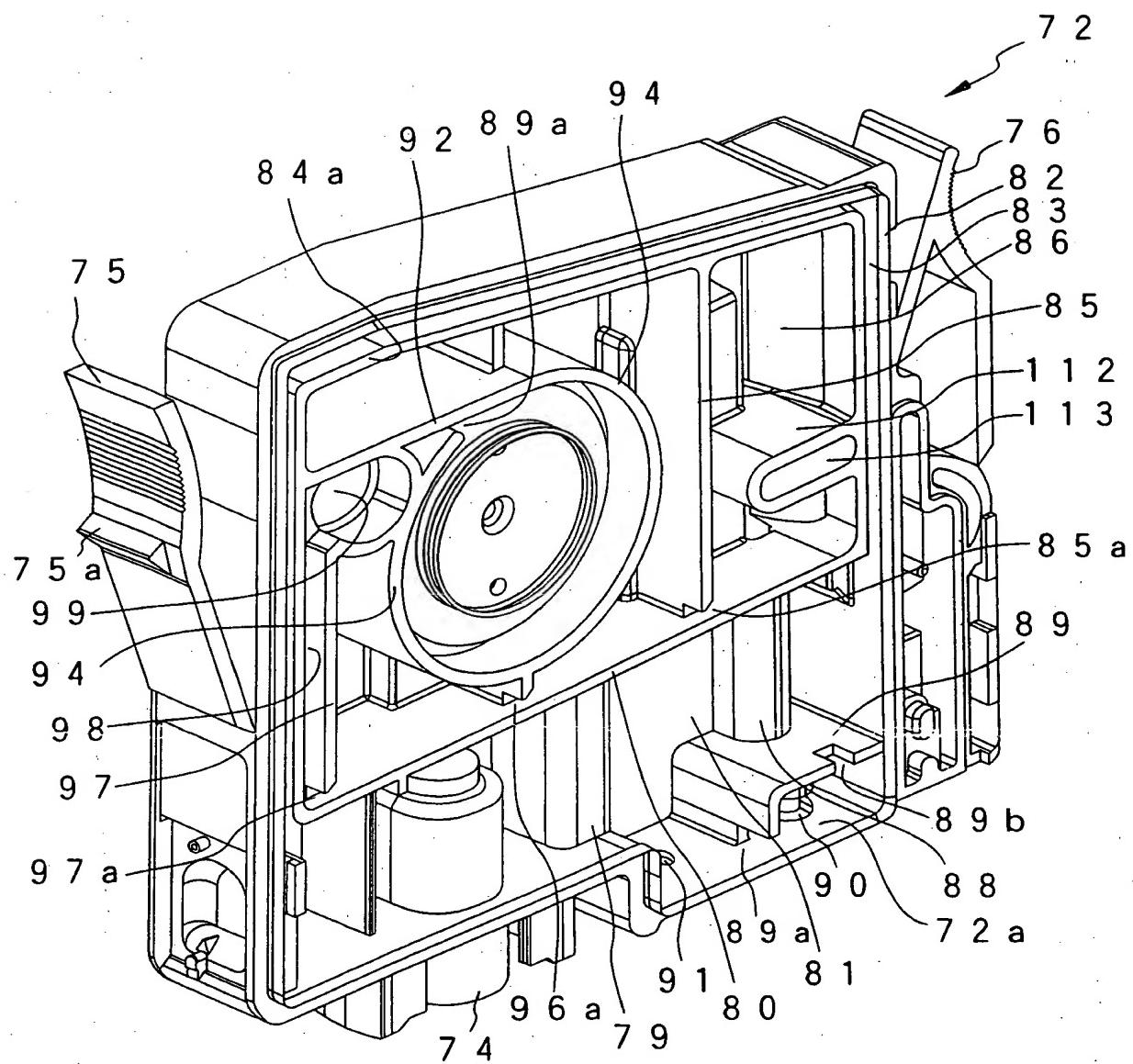


FIG. 14

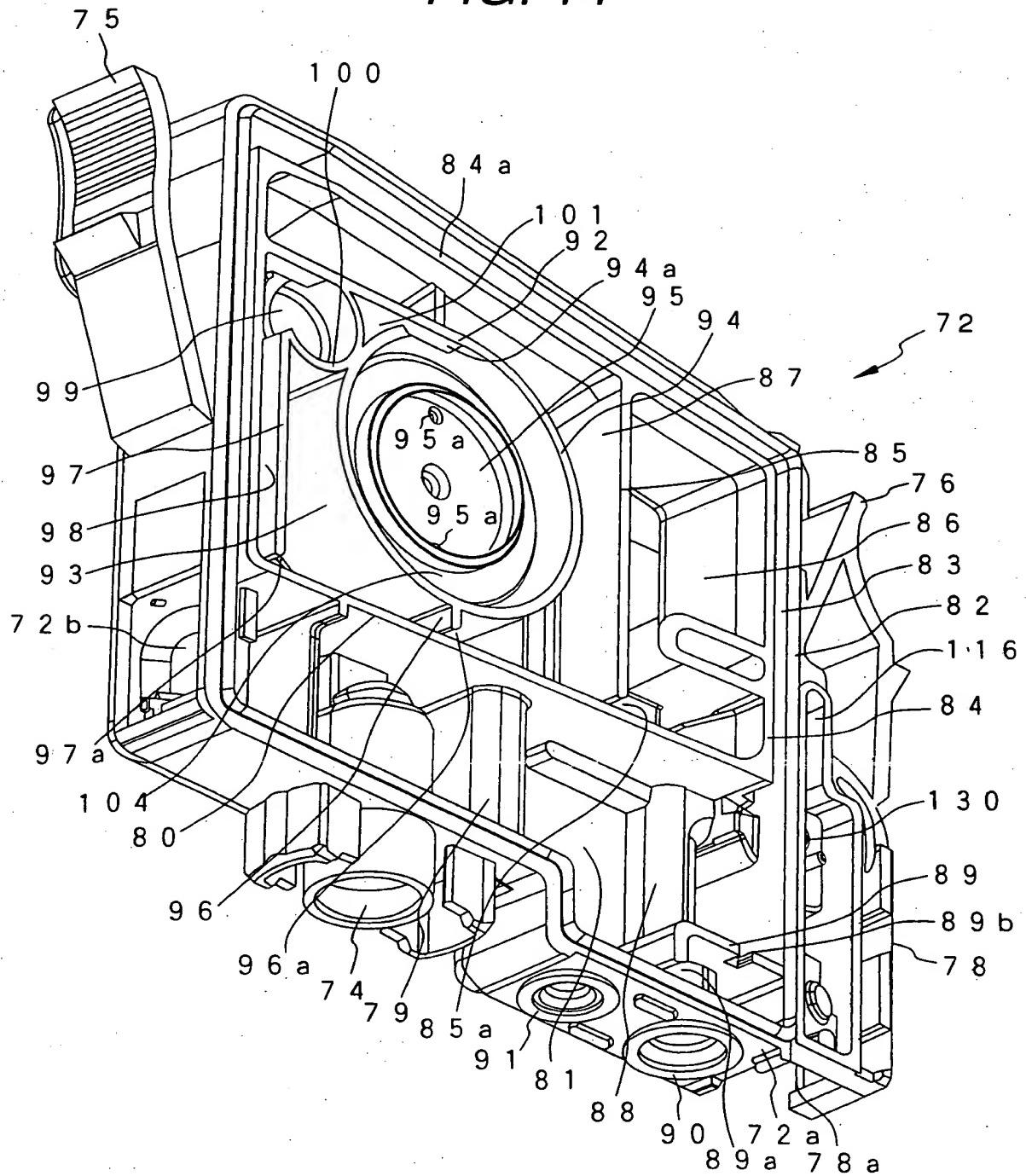


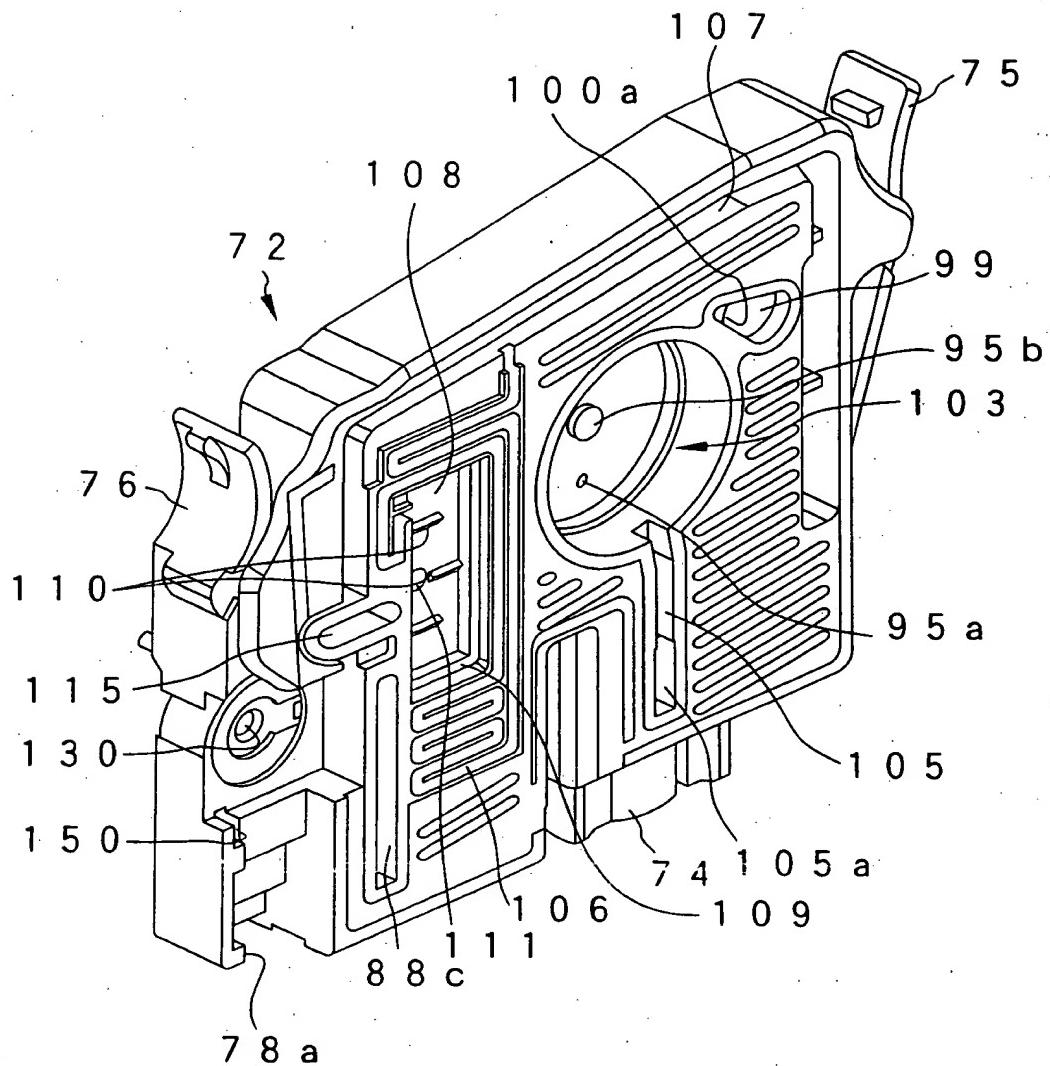
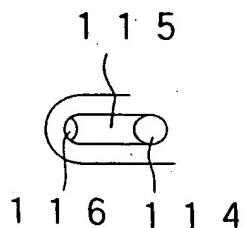
FIG. 15A***FIG. 15B***

FIG. 16

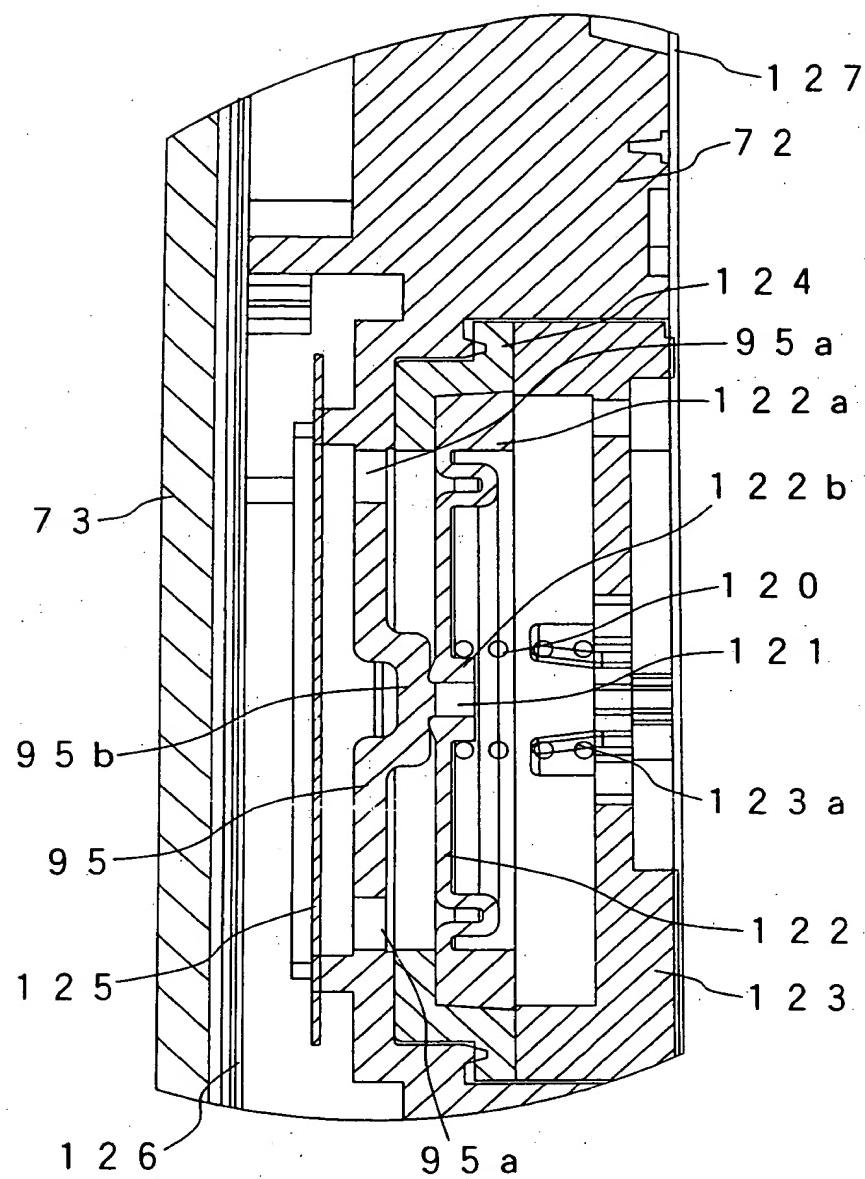


FIG. 17

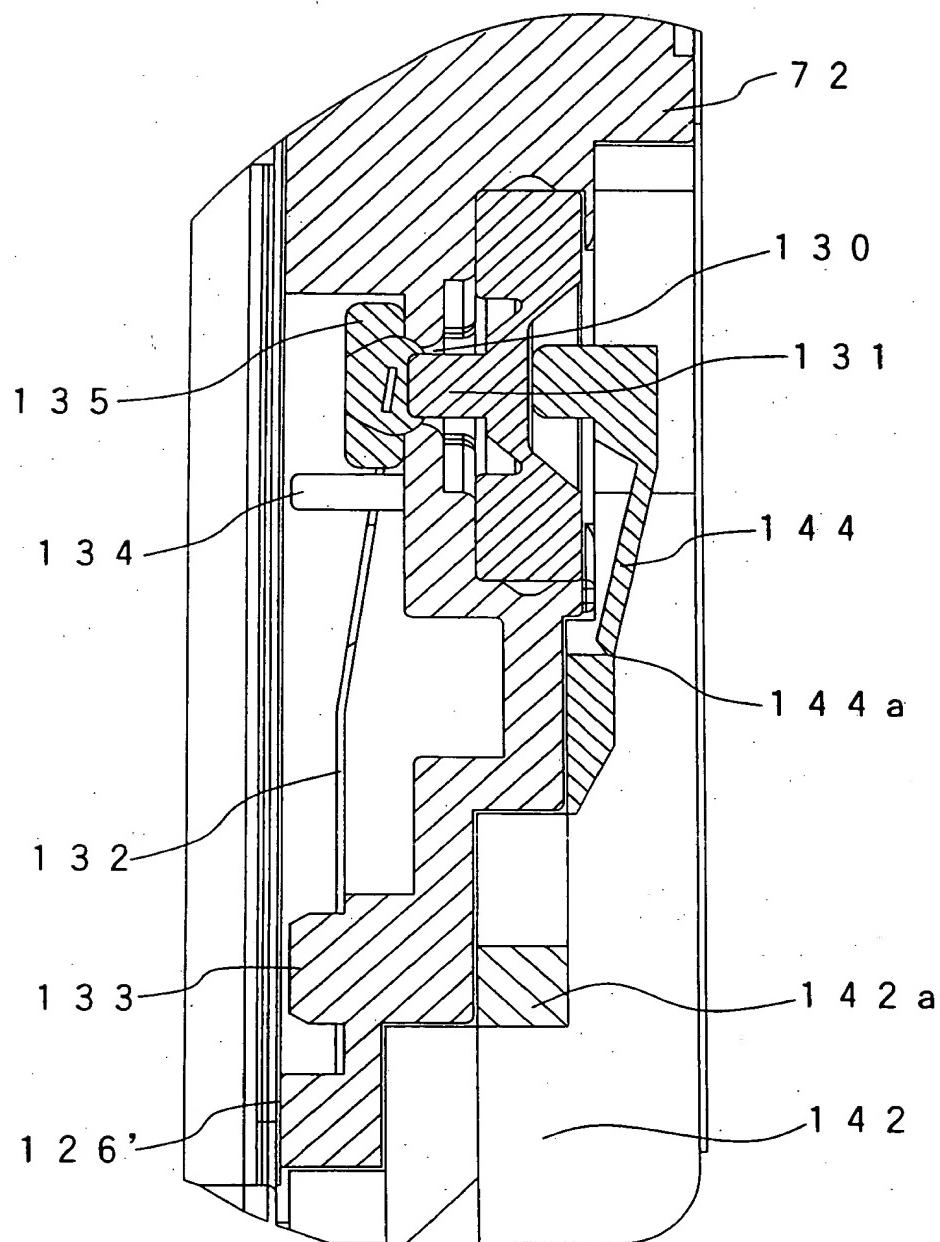


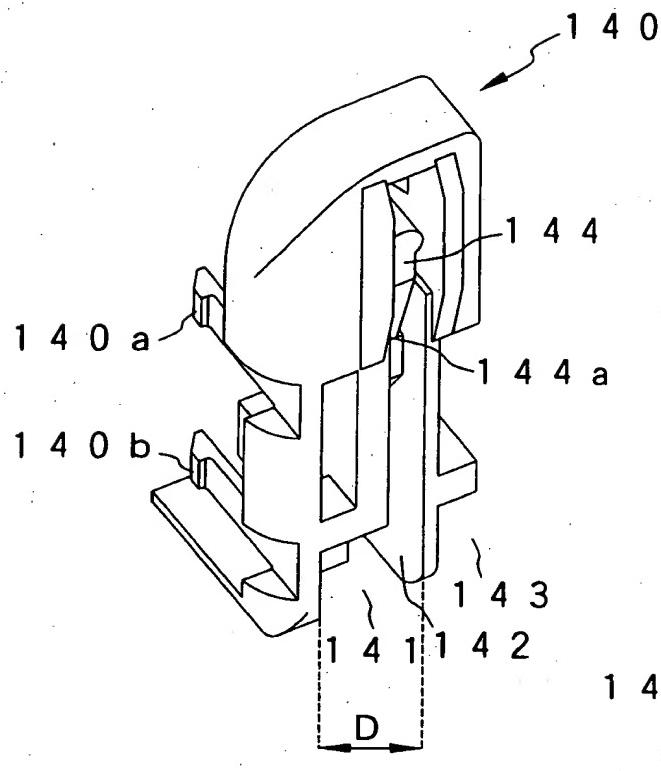
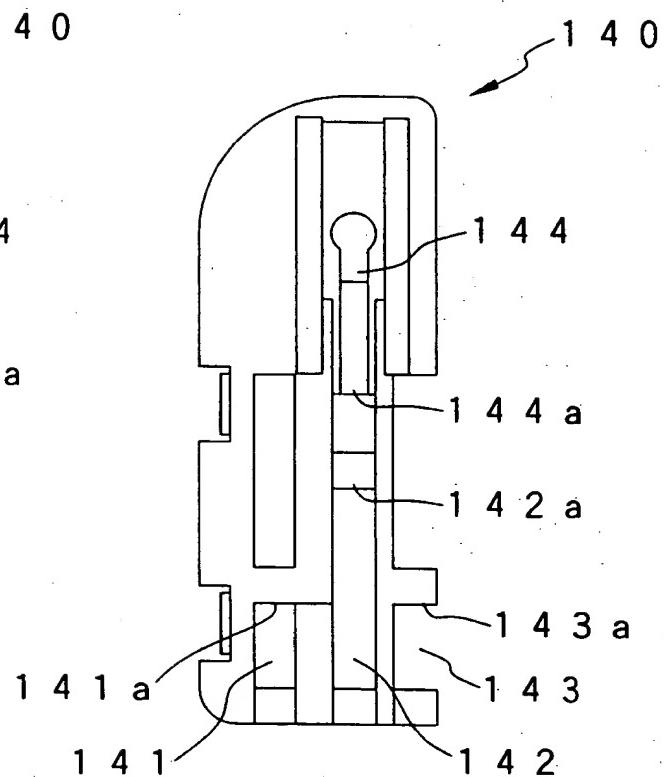
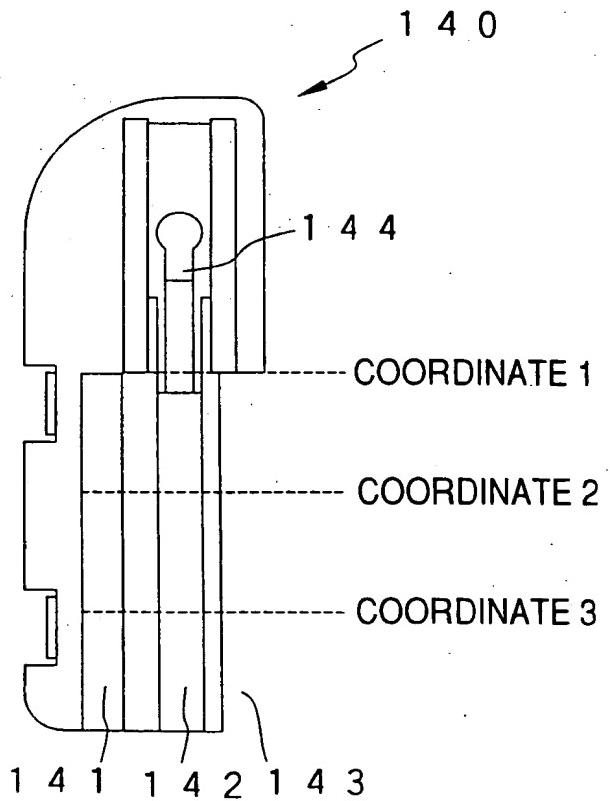
FIG. 18A*FIG. 18B**FIG. 18C*

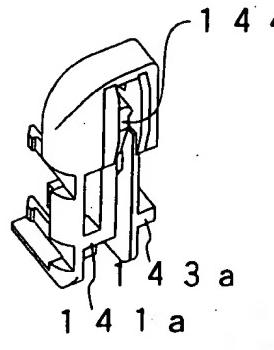
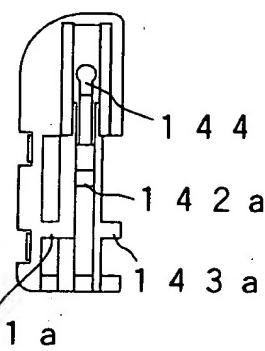
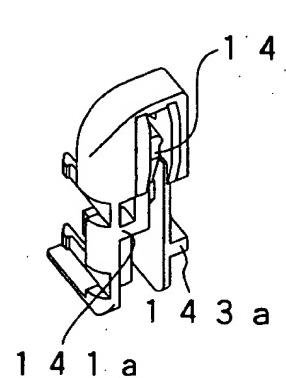
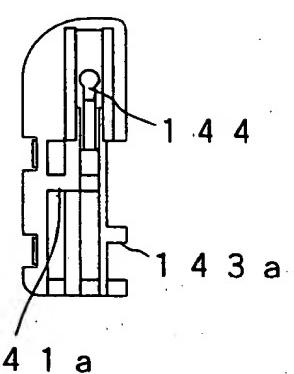
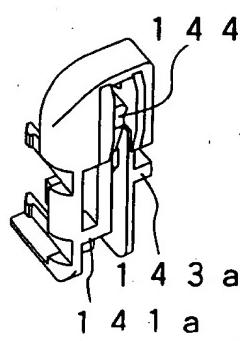
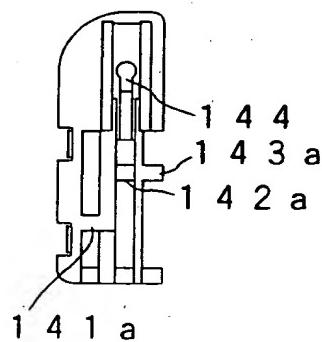
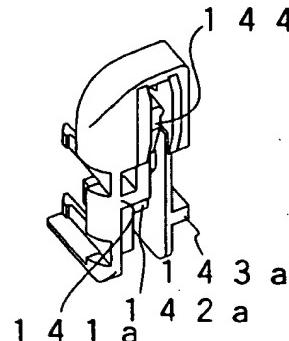
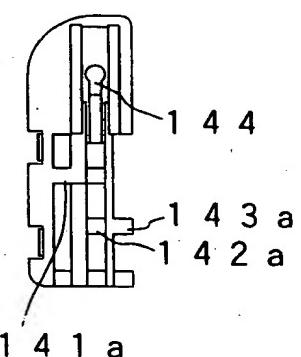
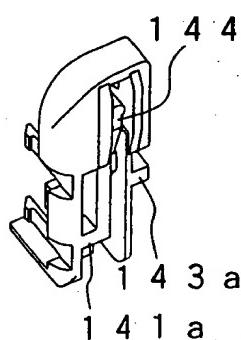
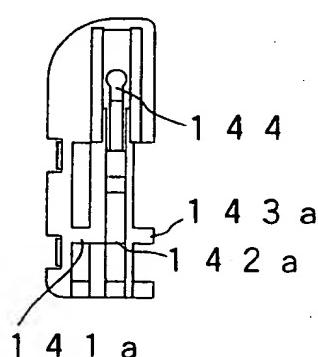
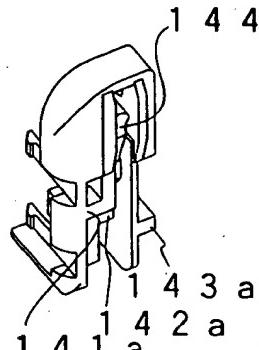
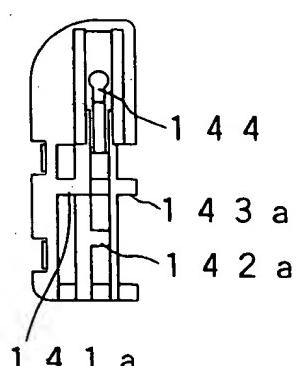
FIG. 19A**FIG. 19A'****FIG. 19B****FIG. 19B'****FIG. 19C****FIG. 19C'****FIG. 19D****FIG. 19D'****FIG. 19E****FIG. 19E'****FIG. 19F****FIG. 19F'**

FIG. 20

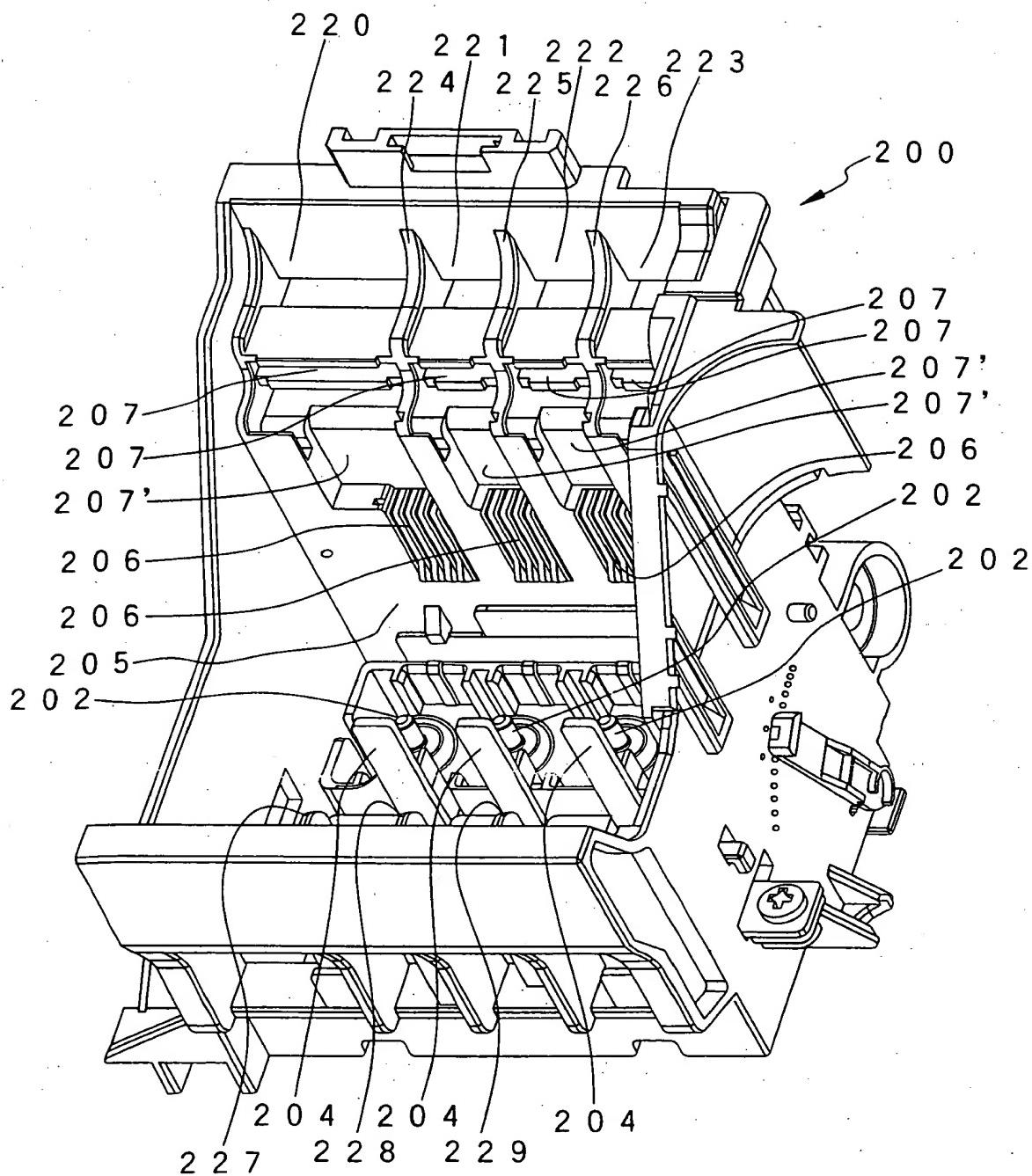


FIG. 21

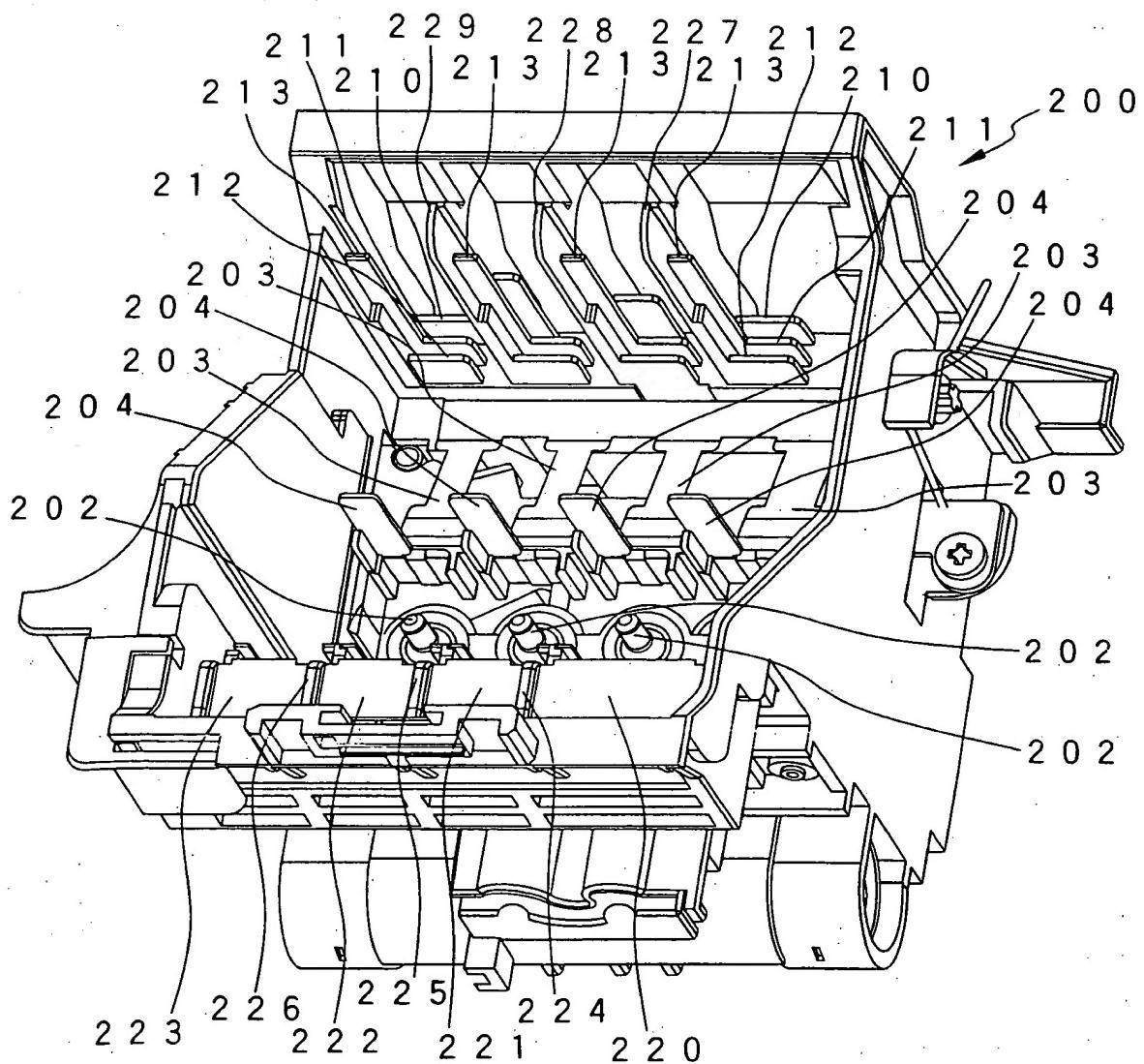


FIG. 22A

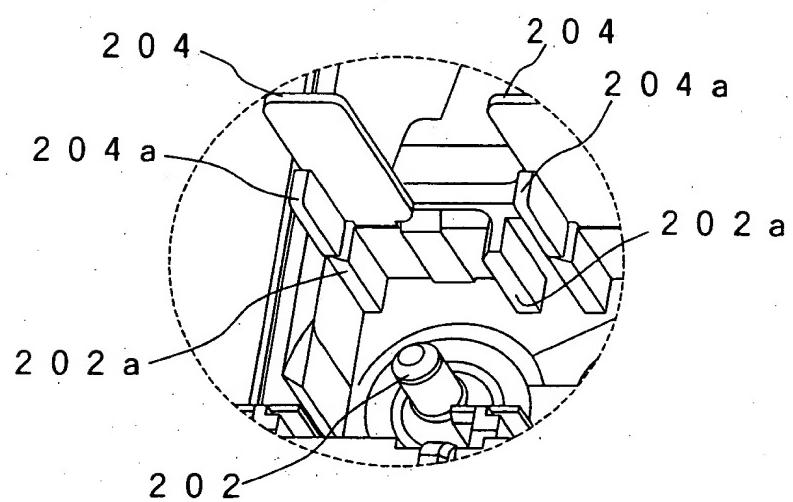


FIG. 22B

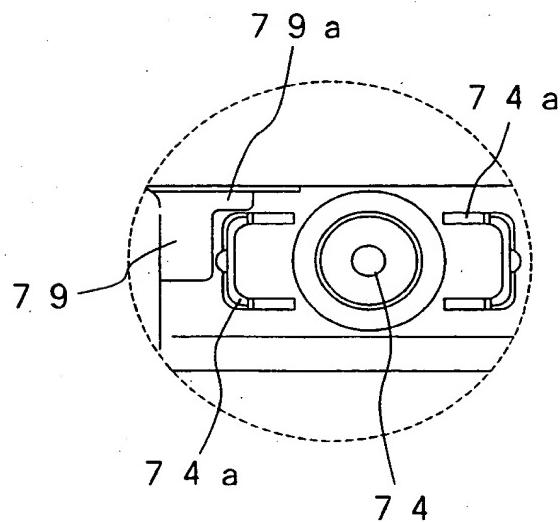


FIG. 23A

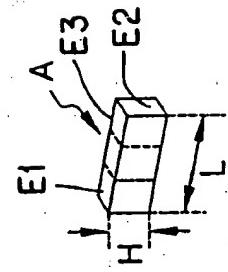


FIG. 23B

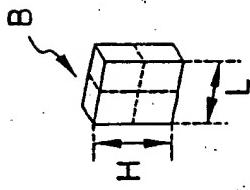


FIG. 23C

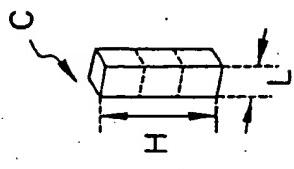


FIG. 23D



FIG. 23E

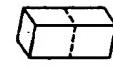
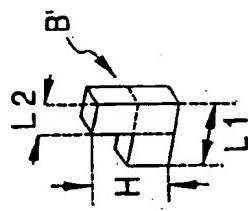


FIG. 23F



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FIG. 24A

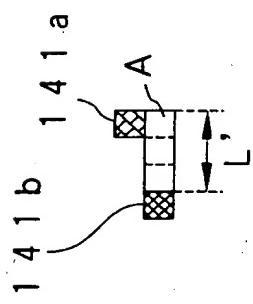


FIG. 24B

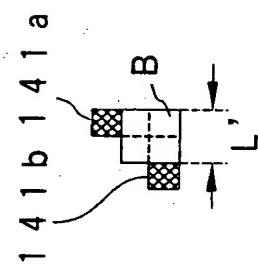


FIG. 24C

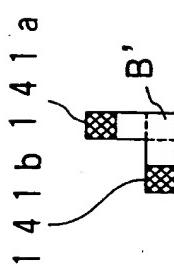
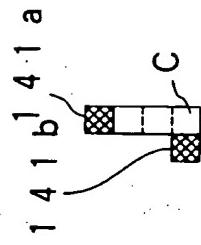


FIG. 25D

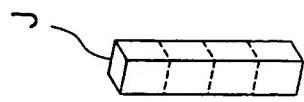


FIG. 25C

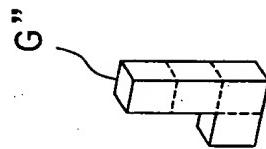
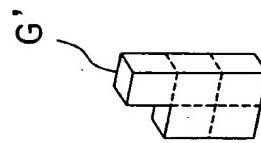
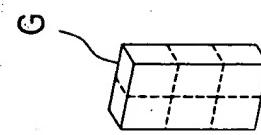


FIG. 25B

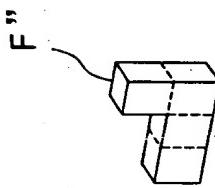
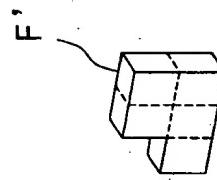
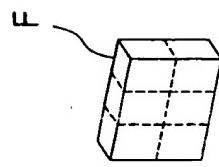
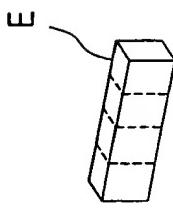


FIG. 25A



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FIG. 26D

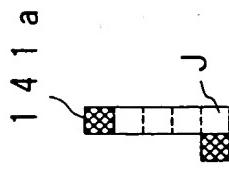


FIG. 26C

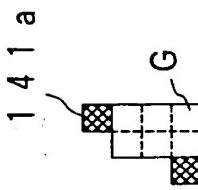


FIG. 26B

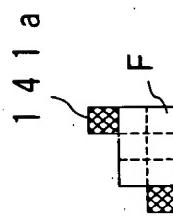


FIG. 26A

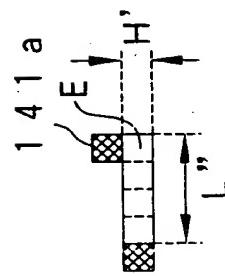


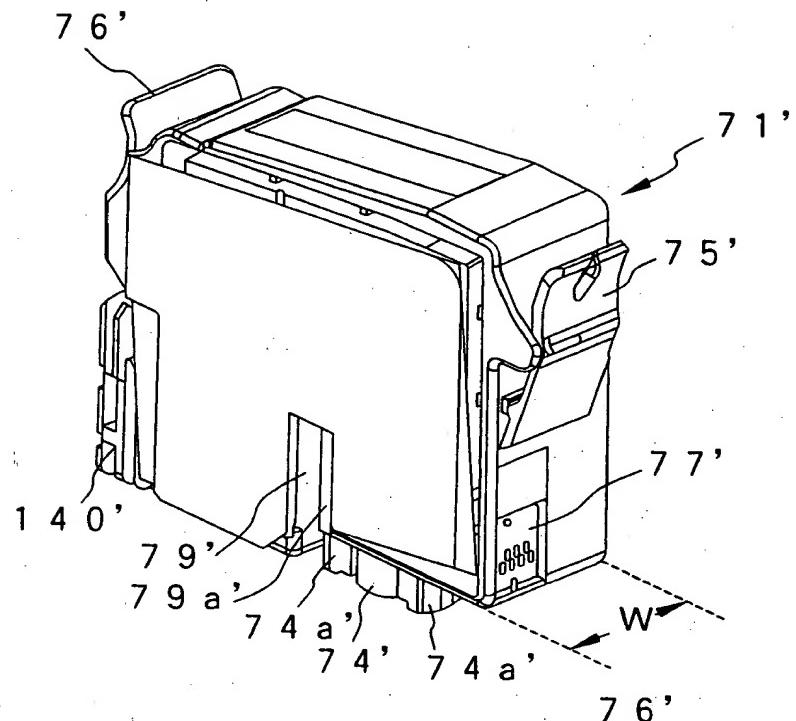
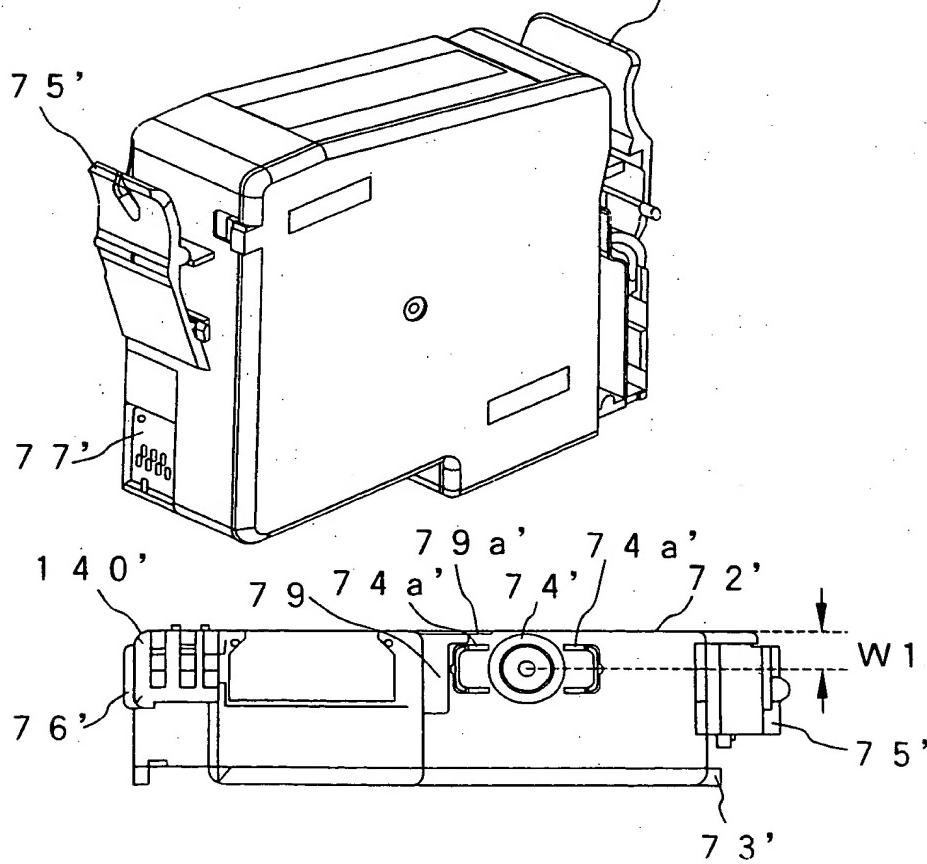
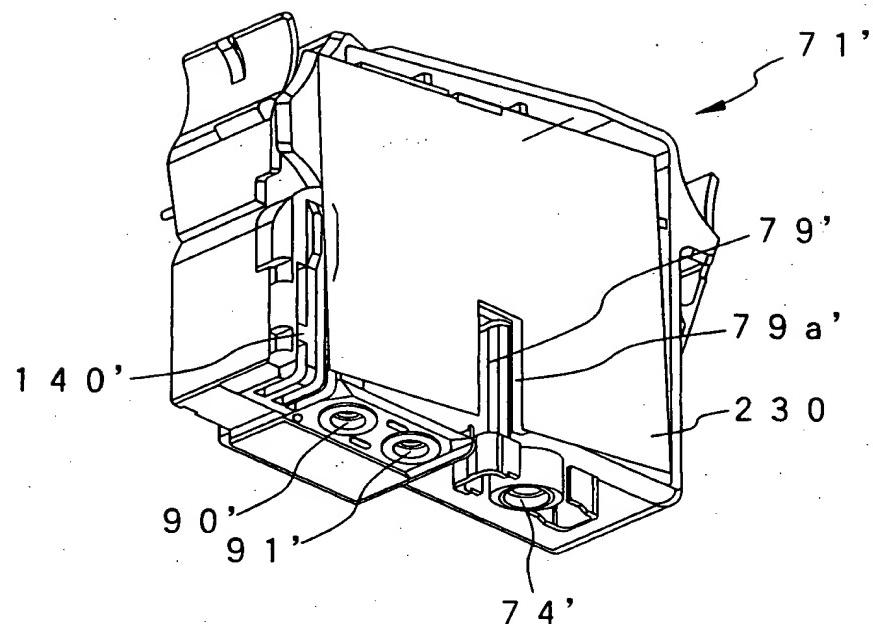
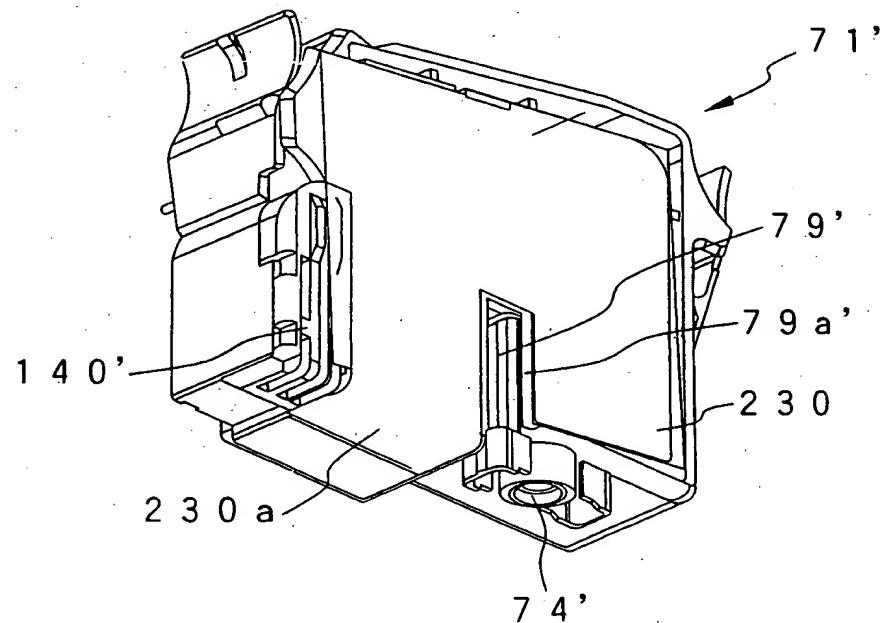
FIG. 27A**FIG. 27B****FIG. 27C**

FIG. 28A**FIG. 28B**

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FIG. 29

